The Work during 1895 of the N. C. Agricultural Experiment Station

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

EIGHTEENTH ANNUAL REPORT

JANUARY 31, 1896

407

Publications will be sent to any address in North Carolina upon application.

N. Carolina Agric. Ex. Station,
July 2, 1897.

N. C. AGRICULTURAL EXPERIMENT STATION,
OFFICE OF DIRECTOR, RALEIGH, N. C.

To His Excellency, ELIAS CARR,
Governor of North Carolina.

SIR: I have the honor to submit herewith a report of the operations of the North Carolina Agricultural Experiment Station for the year ending December 31, 1895.

This report is made in accordance with the following portion of section 3 of the Hatch Act of the Congress of the United States for the maintenance of agricultural experiment stations in the various States and Territories:

"It shall be the duty of each of the said stations, annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures."

Trusting that this report will prove satisfactory to your Excellency, I am, very respectfully yours,

H. B. BATTLE, *Director*.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

W. F. GREEN, *Chairman*, Franklinton.

W. S. PRIMROSE	Raleigh.	J. H. GILMER	Greensboro.
D. A. TOMPKINS	Charlotte.	J. R. MCLELLAND	Mooresville.
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W. R. CAPEHEART	Avoca.	FRANK WOOD	Edenton.

STAFF OF THE EXPERIMENT STATION.

H. B. BATTLE, PH. D	Director and State Chemist.
F. E. EMERY, M. S	Agriculturist.
GERALD MCCARTHY, B. SC	Botanist and Entomologist.
W. F. MASSEY, C. E	Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau)	Meteorologist.
F. E. HEGE	Poultry Manager.
F. P. WILLIAMSON, D. V. S	Consulting Veterinarian.
B. W. KILGORE, M. S	Assistant Chemist.
W. M. ALLEN	Assistant Chemist.
C. B. WILLIAMS, B. C	Assistant Chemist.
S. E. ASBURY, B. S	Assistant Chemist.
ALEXANDER RHODES	Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau)	Assistant Meteorologist.
A. F. BOWEN	Secretary.

RALEIGH, N. C.

SOME VIEWS OF THE N. C. AGRICULTURAL EXPERIMENT STATION AT RALEIGH.

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EIGHTEENTH ANNUAL REPORT

OF THE

DIRECTOR

OF THE

N. C. AGRICULTURAL EXPERIMENT STATION,

FOR 1895,

TO THE GOVERNOR.

The North Carolina Agricultural Experiment Station, as has been frequently stated, was established in March, 1877, with a twofold object in view—first, to act as a Fertilizer Control Station; and second, as an Agricultural Experiment Station in the true sense of the word. Until 1887, the Station was supported entirely by the State from the tax on fertilizers, but by legislative enactment of that year it received the funds derived from the United States Hatch Act for the maintenance of experiment stations in the various states and territories, and the scope of the work was largely increased. The Station receives at present also an appropriation from the North Carolina Department of Agriculture for conducting the work of the Fertilizer Control. The report of the work of the Station for 1895 is embraced under each of its legal functions, the first being

I. THE FERTILIZER CONTROL STATION.

It is hardly necessary to revert to the fact of the value that the fertilizer control has been to the farmers of North Carolina since its organization in 1877. Millions of dollars have been saved, not only in the prevention of actual losses in fertilizer materials, but also in the losses many fold in excess which would have accrued from disastrous crops consequent upon the use of worthless applications.

It will be remembered that up to 1891, the fertilizer trade was subjected to a license tax on each brand of fertilizer sold in the State. Commencing from that year, the present tonnage charge has been in operation.

In order to show the character of the trade for a number of years past, the subjoined table is inserted, giving the character of the different brands on sale in the State during previous years. It will be noted, however, that as licenses did not lapse with the calendar year, a single brand could extend through portions of two years. The numbers, therefore, while showing the number of brands licensed, do not show the actual number on sale during each year. The large increase in the number of brands after 1890 is due to the change from the license tax on each brand to a definite charge upon each ton.

	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895
Acid phosphates or simple superphosphates	9	11	10	9	12	16	59	81	86	86	105
Superphosphates with potash	10	9	8	7	5	4	13	24	22	24	36
Ammoniated superphosphates	63	66	58	62	62	63	178	232	264	284	330
Ammoniated superphosphates without potash	--	--	--	--	--	--	15	12	5	12	11
Kainit	--	--	--	--	--	--	19	25	29	35	38
Other potash salts and chemicals	--	--	--	--	--	--	3	4	6	6	4
Animal bone	--	--	--	--	--	--	--	--	3	3	9
Fish scrap	--	--	--	--	--	--	4	5	4	2	4
Miscellaneous	3	4	1	1	2	1	4	6	8	10	4
Totals	85	90	77	79	81	84	295	389	427	462	541

The number of brands accredited to the several States is as follows, and furnishes an interesting basis for comparison, as it shows to what an extent the trade is distributed among the several States:

	1885	1886	1887	1888	1889	1890	1892	1893	1894	1895
Massachusetts	3	1	4	6	2	2	3	3	3	3
Connecticut	3	1	2	1	1	1	--	--	--	--
New York	4	3	1	1	2	1	8	10	8	7
New Jersey	2	3	2	4	4	5	3	7	2	2
Delaware	4	4	4	3	3	3	--	5	6	2
Maryland	31	35	29	25	28	25	98	106	93	88
Pennsylvania	--	1	--	1	--	--	5	12	7	6
Virginia	18	21	14	12	12	16	96	106	146	189
North Carolina	9	10	11	13	14	18	78	89	98	137
South Carolina	11	11	10	13	15	13	85	82	97	96
Georgia	--	--	--	--	--	--	13	7	1	--
Missouri	--	--	--	--	--	--	--	--	1	11
Totals	85	90	77	79	81	84	389	427	462	541

A casual glance at the above table will show how the number of fertilizer brands accredited to the states of Virginia, North Carolina and South Carolina have increased. This is especially the case with North Carolina, where the increase has been very marked. As further illustrating this increase, the following calculation is inserted, which shows the proportion of the brands on sale which were manufactured in the three States before mentioned, as compared with the total number sold for the different years:

THE NUMBER OF BRANDS OF FERTILIZERS MANUFACTURED IN THE THREE STATES, VIRGINIA, NORTH CAROLINA AND SOUTH CAROLINA, FOR THE YEARS 1885 TO 1895, IN PER CENTS OF THE WHOLE NUMBER.

	1885	1886	1887	1888	1889	1890	1892	1893	1894	1895
Virginia, North Carolina, South Carolina	44.70	46.67	45.45	48.10	50.62	55.95	66.61	64.87	73.81	78.00

In reference to North Carolina alone, the change is more decided. If we consider only the number of licensed brands before 1891 as showing the relative amount of fertilizer sold and the actual proportion of tonnage sold by North Carolina manufacturers after 1891, the increase is very noticeable.

RELATIVE AMOUNT OF FERTILIZER BUSINESS HANDLED BY NORTH CAROLINA FERTILIZER MANUFACTURERS, IN PERCENTAGES OF THE WHOLE.

	1880	1882	1884	1886	1888	1890	1892	1893	1894	1895
North Carolina manufacturers sold in the various years in percentages of whole fertilizer trade:	6.38	6.97	10.00	11.11	16.46	21.43	36.95	37.73	42.15	44.24

It can easily be seen, therefore, that the prediction ventured in 1888 is becoming true. This was, that in ten years one-half of the fertilizers sold in North Carolina would be made within her borders. This means a great deal in a commercial way, for in a large measure the money is kept at home and is serviceable in further use in other industries.

RELATIVE AMOUNT OF FERTILIZER BUSINESS IN 1895 AS COMPARED WITH 1894.

The following table shows the number of firms doing business in North Carolina, together with the location of the fertilizer factories and the relative amount of business done during 1895 and 1894, for the fiscal year ending November 30, as determined by the sale of tags for the same periods:

FIRMS DOING BUSINESS IN NORTH CAROLINA IN 1895, WITH RELATIVE AMOUNT OF SALES AS COMPARED WITH 1894.

	Number of firms.		Number of brands.		Average number of brands per firm.		Relative amount of business handled.	
	1894.	1895.	1894.	1895.	1894.	1895.	1894.	1895.
							pr. ct.	*pr. ct.*
Firms in North Carolina	30	25	98	137	3	5	42.15	44.24
Virginia	21	21	146	189	7	9	37.84	40.71
South Carolina	17	14	97	96	6	7	8.69	7.15
other States	43	29	121	119	3	4	11.32	7.90
Total	111	89	462	541	5	6	100.00	100.00

The first thing that attracts attention in comparing this table with previous ones, is that the trade is being concen-

trated into the two states of North Carolina and Virginia. The reason must be that, considering the item of freights, the trade can be more easily supplied by near-by points; also, that the cost of manufacture is cheaper, and to a certain extent the raw ingredients can more cheaply be procured. The result of these facts is that North Carolina now handles nearly half the trade, and North Carolina and Virginia nearly nine-tenths.

It is noticeable that a larger number of firms from distant States register brands, but their trade is trifling compared with North Carolina and Virginia firms. The average number of brands per firm is twice as great in South Carolina than in North Carolina. Virginia has a still greater proportion as compared with North Carolina.

Digest of Fertilizer Laws Now in Force.

In order to give a short and concise statement of all laws now in operation in regard to the fertilizer inspection and control, the following carefully prepared digest of existing laws is inserted:

No manipulated guanos, superphosphates, commercial fertilizers, or other fertilizing material shall be sold or offered for sale, unless a tonnage charge of twenty-five cents per ton has been paid. Each barrel, package, or bag must have attached a tag representing this fact, which tags are issued by the Commissioner of Agriculture according to regulations prescribed by the Department of Agriculture. The Department of Agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least ten per cent. of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufactories, and accordingly represent the true grade of fertilizers offered for sale.

Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the Commissioner of Agriculture, together with a true sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. The label must set forth the name, location, and trade-mark of the manufacturer; also the chemical composition of contents and real percentage of the ordinary ingredients claimed to be present, together with date of analyzation, and that all charges have been paid. There must be no variation in the guaranteed percentages, but the bags must be branded with the exact chemical composition of the contents. No fertilizer can be sold with a content less than eight per cent. of available phosphoric acid, two per cent. of ammonia, and one per cent. of potash, though in mixed goods these percentages are allowed to vary if there is a large excess of some of the ingredients. Cotton-seed meal is exempted from paying the tonnage charge; also land plaster, agricultural lime, oyster-shell lime, marl, and bulk materials for manufacturing purposes. It is a misdemeanor, and a fine of ten dollars for each bag, for an agent

or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or a railroad agent to deliver it.

Any fertilizer or fertilizing material that does not contain the ingredients as represented by the label is liable to seizure, and, after being established, its value recovered by the Board of Agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law, is liable to a fine of ten dollars for each separate package—one half, less the cost, going to the party suing, and the remainder to the Department; and if such fertilizer is condemned, the Department makes analysis of the same and has printed labels placed on each package, giving the true chemical ingredients of the same, and fixes the commercial value at which it may be sold. The Department of Agriculture can require agents of railroads and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The Experiment Station analyzes the samples of fertilizers taken by the official inspectors, and publishes the same whenever needful.

Increase in Number of Brands, and the Difficulty in a Proper Control.

During the year 1890, the last year of the license tax system, there were 84 brands of commercial fertilizers licensed to be sold in North Carolina. It is very easy to see, under those circumstances (where the number of brands was small) how much easier it was to supervise the fertilizer trade than under the present tonnage system, where the number of brands is almost unlimited. Under the operations of the latter system, the number of brands, including fertilizing ingredients, offered for sale in the State, has increased from 84 in 1890, to 541 in 1895. The difficulties met with in the proper control of the fertilizer trade, under these conditions, have accordingly been very greatly increased, since it is essential that each and every brand of mixed fertilizer or fertilizing ingredient found on sale should be analyzed one or more times during each season.

Valuations of Fertilizers, and how they are Determined.

The valuations of the three constituents, available phosphoric acid, ammonia, and potash, are intended to give the market price for cash at the seaboard of the ingredients making up the fertilizer. The cash prices for small lots in bags, free on board cars, are intended. These valuations are made up early in January of each year, to run through the spring and fall seasons. It is expected that there will be

variations in the market price of the ingredients during the year, but this variation usually is not great. This is because fertilizing materials are largely contracted for in advance before the opening of the year. In most cases the ingredients are already purchased, and the fertilizers already manipulated before the beginning of the season.

The valuations of the constituents are fixed by careful examinations of existing trade conditions, the markets at important centres, and also from actual quotations given by seaboard manufacturers and dealers upon the various ingredients used for manipulating fertilizers. These quotations are for cash in small lots free on board and bagged.

The relative commercial valuation given to the three valuable ingredients for the year 1895 was—

For available phosphoric acid	4½	cents	per	pound.
For ammonia	14	"	"	"
For potash	5	"	"	"

The valuation for potash remains the same as for several years past. The phosphoric acid is reduced one-half cent per pound, it being 5 cents in 1894. The ammonia is also reduced by 1 cent, it being 15 cents per pound in 1894. This decrease was caused by a fall in the price of ammoniates and acid phosphates.

These figures were based as usual on the actual retail cash price of the unmixed ingredients at the seaboard, in bags.

From the commercial valuation of a fertilizer, a farmer, by using these figures, can see the actual cash worth at the seaboard of the unmixed ingredients used in the fertilizer. For interior points, freight of course, must be added. In the bulletins showing the analyses of fertilizers, a table giving the various freight rates from seaboard to interior points is always inserted for convenience of buyers.

The following table shows the average percentage composition, by analysis and by guarantee, of fertilizers sold in 1890, in 1891, in 1892, in 1893, in 1894, and in 1895. The relative seaboard value, both by analysis and guarantee, is calculated on the basis of the last valuations employed for 1895. Except in one slight case, all the materials are very materially higher in grade than is guaranteed.

AVERAGE PERCENTAGE COMPOSITION OF FERTILIZERS ON SALE FOR SEVERAL YEARS.

KIND OF FERTILIZER.	YEAR.	AVAILABLE PHOS. ACID. By Analysis.	AVAILABLE PHOS. ACID. By Guarantee.	AMMONIA. By Analysis.	AMMONIA. By Guarantee.	POTASH By Analysis.	POTASH By Guarantee.	RELATIVE SEABOARD VALUE PR. TON OF UNMIXED INGREDIENTS. By Analysis.	RELATIVE SEABOARD VALUE PR. TON OF UNMIXED INGREDIENTS. By Guarantee.
Acid phosphates	1890	12.92	12.25	----	----	----	----	$ 11.63	$ 11.03
	1891	12.21	12.06	----	----	----	----	10.99	10.85
	1892	12.25	12.01	----	----	----	----	11.03	10.81
	1893	12.93	12.04	----	----	----	----	11.64	10.84
	1894	13.73	12.00	----	----	----	----	12.36	10.80
	1895	13.29	12.21	----	----	----	----	11.96	10.99
Acid phosphates with potash	1890	12.04	10.90	----	----	1.77	1.42	12.61	11.23
	1891	11.17	10.29	----	----	1.66	1.50	11.71	10.76
	1892	11.22	9.97	----	----	2.06	1.53	12.16	10.50
	1893	10.38	9.60	----	----	1.78	1.40	11.12	10.04
	1894	11.27	9.77	----	----	1.77	1.47	11.88	10.26
	1895	10.78	9.32	----	----	2.02	1.93	11.72	10.32
Ammoniated superphosphates with potash	1890	9.11	8.53	2.41	2.29	2.02	1.71	16.96	15.80
	1891	8.11	8.24	2.59	2.51	2.20	1.88	16.75	16.32
	1892	8.70	8.10	2.63	2.46	2.65	2.12	17.84	16.30
	1893	8.37	8.05	2.59	2.47	2.56	1.97	17.35	16.13
	1894	9.04	8.06	2.85	2.76	2.51	2.21	18.63	17.19
	1895	8.84	7.78	3.26	3.05	2.91	2.45	19.94	17.99

Bulletins Containing Fertilizer Analyses.

The plan adopted during the season of 1892 for the first time, in publishing the analyses of fertilizers, has been continued during 1895. This plan proved very acceptable to buyers, and gave them a complete record of the standing of the various brands already analyzed. Early in January of 1895, an analysis bulletin was published which included the various analytical determinations in detail, namely: moisture, soluble, insoluble, reverted, and available phosphoric acid, nitrogen and ammonia, potash, and the relative commercial valuation. There were also given the guaranteed percentage of available phosphoric acid, ammonia, and potash, and the guaranteed value, using the Station's figures for the valuation of the unmixed ingredients at the seaboard. All analyses that were made during the year 1894, both in the spring and fall seasons, were inserted therein. As buyers do not purchase their fertilizers to a great extent before March 1st, this gave ample time to distribute the bulletins into the hands of those who desired to use them in their pur-

chases. This first complete bulletin was sent to the full mailing list of about 14,000 names. Upon the back of the title page was stamped the fact that the analyses for 1895 would be sent out every two weeks during the season, and that parties desiring them would be supplied upon application.

The bi-weekly bulletins contained only the main results of the analysis of each sample of fertilizer, viz.: available phosphoric acid, ammonia, potash, mechanical condition of fertilizer, and relative commercial value, together with the percentages and valuation guaranteed by the manufacturer. These short forms were chosen to facilitate printing the bulletins, the object being to place the analyses at the earliest possible moment, before those who needed them. For most practical purposes these short statements of results answer as well as the complete analyses, though the latter are always included in the analytical work, and are printed in the complete bulletin.

The methods of fertilizer analyses are those of the association of official agricultural chemists as modified by each annual meeting.

II. THE AGRICULTURAL EXPERIMENT STATION.

The second object designed by the State laws of 1877, was the establishment of a true Agricultural Experiment Station. Its functions were to be both scientific and practical, and experiments were to be carried on in various branches of agriculture. The work was commenced and elaborated from time to time as funds would admit, until 1887, when its scope was largely augmented by the means obtained through the Hatch Act of the general government.

The work of the Station, thus enlarged, embraces—

I. Chemical and Microscopical Work, including
1. The analysis of all fertilizers legally on sale in the State.
2. The analysis of agricultural chemicals, of composts and home-made fertilizers, and all materials from which they can be made.
3. The analysis of soils, marls, and muck.
4. The analysis of feeding stuffs.
5. The examination of seeds with reference to their purity, and capacity to germinate.
6. The examination of grasses and weeds.
7. The study of insects injurious to vegetation.
8. The analysis of milk, butter, and other dairy products.
9. Investigation of fungous diseases of plants, and remedies designed to eradicate them.
10. Such other chemical and microscopical investigations as are demanded from time to time.

II. EXPERIMENTAL WORK IN THE FIELD, STABLE, AND DAIRY, including:

1. The effect of different fertilizers on various soils of the State.
2. The study of improved methods for the cultivation of the staple crops.
3. The study of the best treatment of worn-out lands.
4. The study of the best system for the rotation of crops.
5. Chemical investigations, with practical experiments with cattle, on the value of the various forage crops, especially those common in North Carolina.
6. Investigations upon the growth of new crops for this climate, in comparison with those we now have.
7. The construction of the silo, and value of ensilage.
8. The study of the growth of cattle using different feeding stuffs.
9. Investigations in the production of milk and butter under different conditions, and with various implements.
10. Digestion experiments with stock, to ascertain the real value of various food stuffs.
11. Experiments with the various feeding rations, to ascertain how far the feeding standards can be relied on.
12. Tests to compare the value of different varieties of fruits, vegetables, and other horticultural products.
13. Investigations designed to develop the vineyard and trucking interests of the State.
14. Investigations upon the diseases of cattle and domestic animals, and the dissemination of information concerning the treatment of various diseases.
15. Studies as to the best methods of enlarging the poultry business of the State, and placing it upon a profitable footing.
16. Such other work from time to time as may be deemed advisable for the interest of the agriculture of the State.

III. THE COLLECTION AND DISTRIBUTION OF METEOROLOGICAL DATA, such as will directly aid the various agricultural and horticultural industries of the State. The work is of benefit in:

1. The distribution of telegrams to various portions of the State, giving the probable state of the weather for the succeeding twenty-four hours.
2. A foreknowledge of the coming of frosts and cold waves, thereby protecting fruit, trucking, and tobacco interests.
3. The collection of various meteorological data; and by obtaining a more perfect idea of the various climatic conditions, to extend to other localities the crops found useful in portions of this and other States. Also to be able to present to others a better knowledge of the State's unexcelled climate.
4. The collection and distribution of weekly reports showing the effect of the weather on crops during successive periods of their growth.

IV. A BUREAU OF INFORMATION upon all subjects connected with the agricultural industries of the State. Under this head is included

1. Publications of the Station, embracing six different classes of bulletins and three of reports. These publications contain the results of the investigations carried on, as well as a resume of work done elsewhere, in order to instruct or advance the general agricultural interests.
2. Direct correspondence, through the various divisions of the Station, with individual farmers, information being always given as promptly and carefully as possible by those most competent to do so.
3. Personal contact of the Station staff with farmers and others at institutes and fairs, and by visits to farms, etc.

V. SAMPLES FOR EXAMINATION.—Samples, when sent by citizens of the State, for chemical or other examination, will be examined and their value reported free of charge, under certain conditions and stipulations—

1. If the experimental work of the Station will not be retarded thereby.
2. If the work is of an agricultural character.
3. If the samples come from the sender's own lands.
4. If they are of sufficient public interest, and the Station is free to publish the results.
5. If the samples are taken and sent according to the Station's printed forms, and are fully described.

DIVISIONS OF THE STATION.

In order to facilitate the work of the Experiment Station, it has been subdivided into—

1. Executive Division.
2. Chemical Division.
3. Agricultural Division.
4. Botanical Division.
5. Entomological Division.
6. Horticultural Division.
7. Meteorological Division.
8. Poultry Division.
9. Veterinary Division.
10. Division of Publications.

EQUIPMENT.

The headquarters of the station are in the Agricultural Building, Raleigh, immediately north of the State Capitol. In the north wing are located the offices, the chemical laboratories, mailing room, and storerooms. On the basement floor is the document room, where are kept the publications of the station. On the third floor is situated the mycological laboratory, botanical and entomological work-rooms; also the meteorological division of the station, organized as the State Weather Service, and co-operating with the United States Weather Bureau. On the roof of the building and on the third floor are located the various instruments for recording meteorological observations. A thirty-five-foot staff for displaying flags to disseminate weather forecasts is also upon the roof, from which point the signals are visible from a considerable distance.

The Experiment Farm is located about one mile and a half west of the city, and adjoins the fair grounds of the State Agricultural Society. It is in close proximity to the grounds of the North Carolina College of Agriculture and Mechanic Arts, and the students have access to the experiments, and study their progress and their results. On the farm are located the experimental dairy, silos, and barn, in which are the cattle under test for production of beef, milk, and other purposes. Here is also located the poultry work of the station, comprising eight yards and the necessary

equipment for carrying on the work. Field-crop tests are also conducted, as far as is possible, upon the land of the farm. Here, also, is a portion of the field and plant-house work of the horticultural division, the remainder being conducted at Southern Pines. The experiment farm is connected by telephone with the city offices. The electric cars on the Hillsboro street line of the city, stop within easy walking distance of the farm.

Publications of the Station.

The publications of the station have been classified to facilitate preparation, as well as preservation. The bulletins and reports being of such varied character, and mailed to different lists, there must necessarily be some confusion unless this be done.

Accordingly, the following classification has been adopted:

A. Regular Bulletins.—Each edition 14,000 to 26,000 copies. For popular reading, with scientific terms avoided as far as possible. Numbered consecutively 82, 83, 84, etc. Sent to all names on the mailing-list. Last issued during 1895 was No. 123.

B. Technical Bulletins.—Each edition 3,000 copies. Numbered consecutively 1, 2, 3, etc.; also with corresponding number of regular bulletin according to date of issue, 77b, 80c, etc. Sent only to scientific list and exchanges. Summaries of these issues appear in regular bulletins. Last issued was No. 7—91d. This series of bulletins since 1893 have been merged into the series of Regular Bulletins.

C. Meteorological Bulletins.—*Meteorological Division* (*State Weather Service*). Each edition 1,800 copies. Numbered consecutively 1, 2, 3, etc. Sent only to meteorological list and to exchanges. Subject-matter is mainly meteorological data from various stations in North Carolina. Last issued during 1895 was No. 75.

D. Special Bulletins.—Each edition varying in number from 500 to 60,000 copies. For special purposes, as occasion demands. Numbered consecutively 1, 2, etc. Sent only to special names, as occasion demands. This series includes the bi-weekly fertilizer bulletins. Last issued during 1895 was No. 30.

E. Weekly Weather Crop Bulletins.—Each edition 1,600 copies. Numbered consecutively 1, 2, 3, etc., during the year of issue. Gives weekly the effect of the weather upon crops during the growing season. Sent only to crop bulletin list and exchanges. Last issued during 1895 was No. 27.

F. Press Bulletins.—Each edition 600 copies. Numbered consecutively 1, 2, 3, etc. Short reading articles for newspaper columns. First number published was May 24, 1890. Sent to newspaper exchanges and to chairmen of experimental committees of alliances and granges. Last issued during 1895 was No. 73.

G. Annual Reports of the Station.—Each edition 1,000 copies. Numbered consecutively with years, 1–1878, 2–1879, 3–1880, etc. Prior to 1888 these reports contained results of the year's work, and took the place of the separate bulletins which appeared thereafter. The annual reports now contain copies of the regular bulletins issued during the year. Sent to exchanges only, and not to general mailing-list. Last issued was seventeenth annual for 1894.

H. Annual Reports of the Meteorological Division, *constituting the State Weather Service.* Each edition 2,000 to 4,000 copies. Numbered consecutively with years, 1–1887, 2–1888, 3–1889, etc. Includes monthly and annual means of meteorological data at various stations in North Carolina and for the State, with other records made and work done during the year; also copies of meteorological bulletins of series C issued during the year. Sent to meteorological exchange list only. Last issue was eighth annual for 1894.

I. Biennial Reports of the Station.—Sent to the Governor for transmission to the General Assembly. Each edition 500 to 3,000 copies. Numbered consecutively 1–(1887, 1888), 2–(1889, 1890), 3–(1891, 1892), etc. These reports are demanded by State authorities, and are not intended for general distribution. Last issue was Eighth Biennial Report for the years 1893 and 1894.

J. Information Bulletin.—Designed for distribution to collect information concerning practical and useful plans of farm management or methods of cultivation of different crops, etc., to be collated thereafter for use in general bulletins. The last issue was No. 5.

Since the above general plan was adopted, it has been found that some confusion occurred in the classification of A and B (regular and technical bulletins). To remedy this, it was decided to merge the latter series into the former, and to give a popular summary of the technical work, which summary is alone to be sent to the general list of farmers throughout the State. The full detailed report of the technical work is mailed, as usual, to the scientific and exchange lists. Others can secure each of these publications by special application therefor. This plan prevents wasteful distribution of bulletins to those who do not have the time or the inclination to investigate the detailed portions of the technical work, and supplies to farmers only what they most generally wish to know, *i. e.*, the results of the work.

Publications During the Year 1895.

During the year 1895, seventy distinct publications have been issued, subdivided as follows:

Series A—Regular Bulletins—13 bulletins, containing 384 pages.
" C—Monthly Meteorological Bulletins—12 bulletins, containing 200 pages.
" D—Special Bulletins—9 bulletins, containing 120 pages.
" E—Weekly Weather Crop Bulletin—27 bulletins, containing 27 pages.
" F—Press Bulletin—7 bulletins, containing 7 pages.
" G—Annual Report of Station—1 report, containing 88 pages.
" H—Annual Report State Weather Service—1 report, containing 52 pages.
Total during 1895, 70 publications, containing 878 pages.

A. OF THE REGULAR BULLETINS, 13 ISSUES.

No. 111.—Fertilizer Analyses of the Fertilizer Control.
January 12, 1895. 26 pp. Including official analyses of spring and fall samples of 1894. The Fertilizer Control Station. When analyses of fertilizers are made for farmers. The necessity for accurate sampling. The need of fertilizer analyses. Terms used in analyses. How the valuation of constituents are determined. How values per ton are calculated, and how they can be utilized by farmers. Table of freight rates from the seaboard to interior points. Analyses of 266 samples of fertilizers taken and analyzed during the year 1894.

No. 112.—Trucking in the South.
January 16, 1895. 70 pp. Especially adapted to the needs of North Carolina cultivators. Preface. Introduction. Varieties of vegetables and their culture, including asparagus, beans (snap and lima), beets, early and late cabbages, cauliflower and lettuce, cucumbers, celery, egg plant, kale, muskmelons, watermelons, onions, peas, Irish potatoes, sweet potatoes, radishes, tomatoes, and turnips. Appendix. The mixing of fertilizers for trucking crops.

Needs of certain trucking crops. Table of average weight of fertilizing constituents in 1,000 lbs. of trucking crops. Table of average yield of trucking crops, and the weight of the fertilizing ingredients contained in them. Ingredients used in mixing fertilizers. Table of average percentage composition of fertilizing ingredients. Average cost of fertilizing ingredients. Special mixtures for special crops. How to calculate the proportions of a fertilizer to yield definite percentages. Total cost of the ingredients in mixed fertilizers. Table of freight rates from the seaboard to interior points, in car load lots. Mixing the ingredients. Special formulas suggested for trucking crops.

No. 113.—The Testing of Milk.

June 15, 1895. 32 pp. Preface. The Babcock milk test. The detection of adulterations in milk. Buying and selling cows by tests of their milk. The practical value of milk testing.

No. 114.—Tests of Dairy Implements and Practices.

June 20, 1895. 32 pp. The Berrigan separator. The Horizontal De Laval separator. The Cooley creamer. The ordinary milk-setting system. The U. S. hand separator. The Victoria hand separator. Table of contents. Comparisons with the Berrigan separator, the Horizontal De Laval separator, the Cooley creamer, and the ordinary milk-setting system in water and in air.

No. 115.—Miscellaneous Agricultural Topics.

June 22, 1895. 20 pp. Articles contained in the press service bulletins of September, 1894, to February, 1895.

No. 116.—Milk Record and Tests.

June 24, 1895. 16 pp. Milk records at the Experiment Farm. Variations of milk yield caused by variations in milking. A test showing that cows are affected by changes in stable routine.

No. 117.—Tuberculosis and its Prevention.

June 28, 1895. 20 pp. Introductory. Tuberculosis. Tuberculin tests at this station. Test with Tuberculin by Dr. Joel Hill, Arcadia.

No. 118.—Cotton-seed Hulls and Meal for Beef Production.

July 6, 1895. 40 pp. A discussion of the digestibility of the rations. The effect of meal on the digestibility of hulls. The fertilizing constituents of the rations recovered in the manure.

No. 119.—Volumetric Estimation of Phosphoric Acid.

August 15, 1895. 24 pp. The estimation of phosphoric acid by titration of the yellow precipitate of ammonium phospho-molybdate. The estimation of phosphoric acid in soils by double precipitation with molybdic solution, and titration of the ammonium phosphomolybdate with standard alkali.

No. 120.—Cultivation of the Peach Tree.

September 18, 1895. 36 pp. The peach tree and its parasites. Apparatus and formulas. Insect enemies of the peach tree. The fungous parasites of the peach tree. Legal measures for repressing infectious diseases of the peach and plum. Varieties of peaches. The planting, pruning, and cultivation of the peach. Shall we plant seedlings or budded trees? Site and soil for a peach orchard. Planting an orchard. The kind of trees to plant. Planting the trees. Pruning the tops after transplanting. Starting the top. Cultivation of the peach orchard. Fertilizers for the peach. Gathering the crop. Varieties. Canning. The peach belt of North Carolina.

No. 121.—Hillside Terraces or Ditches.

October 15, 1895. 12 pp. Plate showing field with incipient hillside washes, and deep gullies caused by incomplete ditching. The leveling instrument. Plate showing a Mangum hillside terrace on the farm of the North Carolina College of Agriculture and Mechanic Arts. Crops are planted and cultivated upon the terrace. Laying off the terrace. Farming the terrace.

No. 122.—Types of Tobacco and their Analyses.

November 7, 1895. 40 pp. Introduction. Production of tobacco in the United States. Varieties and classification of tobaccos. Tobacco soils. Fertilizers. The development of nicotine in the tobacco plant. On separating the stem from the leaf in tobacco analyses. The composition of various tobaccos. Burning qualities. Relation existing between chemical composition and burning quality. General observations.

No. 123.—Miscellaneous Agricultural Topics.

December 14, 1895. 16 pp. Articles contained in the press service bulletins of August to November, 1895.

C. OF THE STATE WEATHER SERVICE DIVISION, 12 ISSUES.

No. 64.—North Carolina Weather during January, 1895.

January 31, 1895. 16 pp. General remarks. Notes by voluntary observers. Summary: atmospheric pressure, air temperature, precipitation, humidity, wind, and weather. Dates of thunderstorms, hail or sleet, solar and lunar halos, and fog. Charts showing normal temperature and precipitation for January in North Carolina. Tables of daily mean, maximum and minimum temperatures, and daily precipitation. Monthly summaries from 54 observers.

No. 65.—North Carolina Weather during February, 1895.

February 28, 1895. 16 pp. Contents similar to No. 64. Monthly summaries from 55 observers.

No. 66.—North Carolina Weather during March, 1895.

March 31, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 56 observers.

No. 67.—North Carolina Weather during April, 1895.

April 30, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 60 observers.

No. 68.—North Carolina Weather during May, 1895.

May 31, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 56 observers.

No. 69.—North Carolina Weather during June, 1895.

June 31, 1895. 16 pp. Contents similar to No. 64. Monthly summaries from 58 observers.

No. 70.—North Carolina Weather during July, 1895.

July 31, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 57 observers.

No. 71.—North Carolina Weather during August, 1895.
August 31, 1895. 20 pp. Contents similar to No. 64. American Association of State Weather Services, with topics for discussion at the fourth annual convention to meet at Indianapolis, Indiana, October 16 and 17, 1895. Monthly summaries from 58 observers.

No. 72.—North Carolina Weather during September, 1895.
September 30, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 53 observers.

No. 73.—North Carolina Weather during October, 1895.
October 31, 1895. 18 pp. Contents similar to No. 64. Monthly summaries from 55 observers.

No. 74.—North Carolina Weather during November, 1895.
November 30, 1895. 16 pp. Contents similar to No. 64. Monthly summaries from 49 observers.

No. 75.—North Carolina Weather during December, 1895.
December 31, 1895. 16 pp. Contents similar to No. 64. Monthly summaries from 52 observers.

D. OF THE SPECIAL BULLETINS, 9 ISSUES.

No. 22.—Fertilizer Analyses of the Fertilizer Control.
February 16, 1895. 12 pp. First bi-weekly edition, season of 1895. The present fertilizer laws. Terms used in an analysis. How the valuations of constituents are determined. How values per ton are calculated, and how they can be utilized by farmers. Table of freight rates from the seaboard to interior points. Analyses of 49 samples analyzed by the fertilizer control.

No. 23.—Fertilizer Analyses of the Fertilizer Control.
March 2, 1895. 14 pp. Second bi-weekly edition, season of 1895. Contents similar to No. 22. Analyses of 96 samples analyzed by the fertilizer control.

No. 24.—Fertilizer Analyses of the Fertilizer Control.
March 16th, 1895. 16 pp. Third bi-weekly edition, season of 1895. Contents similar to No. 22. Analyses of 133 samples analyzed by the fertilizer control.

No. 25.—Fertilizer Analyses of the Fertilizer Control.
March 30, 1895. 18 pp. Fourth bi-weekly edition of the fertilizer control. Contents similar to No. 22. Analyses of 179 samples analyzed by the fertilizer control.

No. 26.—Fertilizer Analyses of the Fertilizer Control.
April 13, 1895. 20 pp. Sixth bi-weekly edition, season of 1895. Contents similar to No. 22. Analyses of 224 samples analyzed by the fertilizer control.

No. 27.—Fertilizer Analyses of the Fertilizer Control.
April 27, 1895. 4 pp. Sixth bi-weekly edition, season of 1895. Issued as a supplement to No. 26. Analyses of 31 additional samples analyzed by the fertilizer control.

No. 28.—Agricultural Suggestions to the Waldensians.
May 4, 1895. 26 pp. General suggestions. Growing wheat. The corn crop and subsequent rotation. Irish potatoes. Cabbages for winter use. Sweet potatoes. Turnips. Early spring cabbages. What is manure? Recuperative crops and the rotation of crops. Taking care of home-made manures.

No. 29.—Fertilizer Analyses of the Fertilizer Control.
May 11, 1895. 4 pp. Seventh bi-weekly edition, season of 1895. Contents similar to No. 27. Analyses of 50 samples analyzed by the fertilizer control.

No. 30.—Fertilizer Analyses of the Fertilizer Control.
May 25, 1895. 4 pp. Contents similar to No. 27. Analyses of 53 samples analyzed by the fertilizer control.

E. OF THE WEEKLY WEATHER CROP BULLETINS, 27 ISSUES.

Nos. 1 to 27.—Weekly Weather Crop Bulletin.
April 8, 1895, to October 5, 1895. Issued every Monday afternoon during the crop season. 365 reporters, representing all of the 96 counties of the State.

F. OF THE PRESS BULLETINS, 7 ISSUES.

No. 67.—February 25, 1895.
Articles: The Experiment Station bulletins. Fertilizer analyses for 1895 Hog cholera. The ox warble or heel fly. How relative values per ton are calculated for fertilizers, and how they can be utilized by farmers. Cotton-seed feed. Questions and replies. Influence of the moon. Feeding cotton-seed products. Top-dressing for clover. Building a silo. Cutting oats for feed.

No. 68.—March 15, 1896.
Articles: Cow-peas for distribution. Teosinte. Sacaline.

No. 69.—August 20, 1895.
Articles: Harvesting and threshing cow-peas by machinery. Insect pests of shade-trees. Advanced monthly summary of meteorological reports for North Carolina, July, 1895. North Carolina weather during 1894. Feeding calves. Questions and replies. Acid phosphate of different grades. Grasses for hay and comparative values of hay. The lesser locust injuring crops.

No. 70.—October 28, 1895.
Article: Co-operative creamery associations.

No. 71.—October 29, 1895.
Articles: Crop conditions during September, 1895. Rust in small grain. Advanced monthly summary of meteorological reports for North Carolina, September, 1895. The North Carolina Agricultural Experiment Station during 1894. Co-operative dairying. Trucking in the South. Questions and replies. Onions for market. The harlequin bug. Beets for stock feed. Variety of trees for peach orchard. Varieties of trees for apple orchard.

No. 72.—November 20, 1895.

Articles: Bee culture at the Experiment Station. Bee culture. The care of bees in winter.

No. 73.—November 30, 1895.

Articles: Buying and selling cows by tests of their milk. Beware of travelling seed-peddlers. The new poultry division. Advanced monthly snmmary of meteorological reports for North Carolina, Ootober, 1895. The testing of milk. A new cabbage pest. Questions and replies. The growing of onions. Do oats impoverish the soil more than wheat?

G. OF THE ANNUAL REPORTS OF THE STATION, 1 ISSUE.

No. 17.—The N. C. Agricultural Experiment Station during 1894.

January 31, 1895. 88 pp. Bound with the bulletins issued during 1894, pp. 606. Report of the director. Letter of transmittal. Officers of the Board and Experiment Station. Illustrations showing some of the station work at Raleigh. The fertilizer control station. The agricultural experiment station. Report of the agriculturist. Report of the first assistant chemist. Report of the botanist and entomologist. Report of the horticulturist. Report of the meteorologist. Financial statement. Bulletins Nos. 94 to 110 inclusive issued during 1894.

H. OF THE ANNUAL REPORTS OF THE METEOROLOGICAL DIVISION, 1 ISSUE.

No. 8.—North Carolina Weather during the year 1894.

April 19, 1895. 52 pp. Bound with the bulletins issued during 1894. 256 pp. Publications of the North Carolina State Weather Service for 1894. Collection of meteorological data, and list of meteorological stations and observers during 1894. Weekly weather crop bulletin and list of crop correspondents during 1894. Weather and temperature forecasts, and lists of stations in North Carolina receiving forecasts during 1894. Brief account of the river and flood service in North Carolina. Annual meteorological summary for 1894. Comparisons of temperature and precipitation at stations in North Carolina, United States, and in foreign countries. Charts of normal annual temperature and precipitation for North Carolina. Bulletins Nos. 52 to 63 inclusive, issued during 1894.

THE VALUE OF THE STATION'S PUBLICATIONS.

Of the value that the station's publications have proven to readers, we are constantly receiving evidence from one end of North Carolina to the other, and from other states and countries. The plan of sending to each name listed popular summaries of the subjects treated, in place of the more elaborate and complete details where such will be of little general interest, has continued to be appreciated in

the same measure. The following extract from the *New York Weekly World* will illustrate the favor with which this plan is received:

"The condensed summary of bulletin No. 93, of the North Carolina Station, is short, simple, and admirably adapted to the purpose in view—that of compelling the attention of the man who throws the ordinary bulletin aside unread. Nor is he entirely to be blamed for this neglect. The farmer, tired after a hard day's work, cannot be expected to have any inclination to wade through a long scientific account of experiments described in language which necessitates the constant use of a dictionary. He wants facts, expressed simply and tersely. This the North Carolina Station has attempted in its recent bulletin, and it is to be congratulated on the result. The feeding experiments it reports will be read with interest and profit by all those interested in fattening beeves for market."

Another advantage which results from the adoption of the plan is that the Station is enabled to issue more bulletins with a given amount of printing fund.

The press service bulletins continue to prove of much interest and value to many. These popular articles for general reading present the work of the Station in a short, concise way, and include other information of general agricultural interest. A special feature of these bulletins is the Question and Reply column.

A revision of the mailing lists of the Station has been found necessary, on account of the many removals, deaths and other causes. This has been successfully accomplished, though the task is tedious and expensive. The list at this writing includes 16,482 names, the large majority being names of farmers in North Carolina. It is needless to say that the list is constantly increasing.

Acknowledgments.

The Station takes pleasure in acknowledging the receipt during 1895 of the books and pamphlets, journals and newspapers stated below. The reports and bulletins of the U S. Department of Agriculture, and of the various experiment stations in the different states, Canada, and abroad, are not included in the list, but are regularly received.

BOOKS AND PAMPHLETS.

Royal Agricultural Society, London, England. Journal of Society; vol. 5, part 4; vol. 6, parts 1, 2 and 3.

Prof. E. A. Smith, State Geologist, University Alabama. Geological Map of Alabama. Coastal Plain of Alabama. Report on Coosa Coal Fields.

Georgia Department of Agriculture, Atlanta. Publications of the Department for 1894,

Col. F. H. Cameron, Raleigh. Report of Adjutant-General of North Carolina for 1894.

North Carolina Railroad Commission, Raleigh. Report for 1894.

California Board of Horticulture, San Francisco. Report for 1894.

North Carolina Bureau of Labor Statistics, Raleigh. Report for 1894.

Society for Promoting Agriculture, Boston, Mass. Infectiousness of milk.

Florida Horticultural Society, Jacksonville. Proceedings for 1894.

Dr. J. L. Miller, Goldsboro. Report of Superintendent of Eastern Hospital, Goldsboro, N. C., for 1894.

Minnesota Dairy and Food Commission, St. Paul. Report for 1894.

W. A. Burpee & Co., Philadelphia. Work at Fordhook Farm.

New York Board of Health, Albany. Report for 1894.

New York City Health Department. Scientific Bulletin, No. 1.

American Museum of Natural History, New York City. Bulletin, vol. 6, 1894.

German Kali Works, New York City. Die Kalidüngung.

Society of Natural History, Cincinnati, Ohio. Journal for 1894.

Michigan Board of Health, Lansing. Proceedings for 1894.

Prof. T. Jamieson, Aberdeen, Scotland. Proceedings of Agricultural Research Association for 1894.

Oregon Board of Horticulture, Portland. Report for 1894.

Schimmel & Co., New York City. Semi-annual Report for 1894.

C. G. Lloyd, Cincinnati, O. Drugs and Medicines of North America.

Elisha Mitchell Scientific Society, Chapel Hill, N. C. Journal of the Society for 1894; parts 1 and 2.

Kansas Board of Agriculture, Topeka. Report for 1894.

North Carolina Board of Health, Raleigh. Fifth Biennial Report for 1893 and 1894.

Massachusetts Board of Agriculture, Boston. Report for 1894. Report on the Gypsy moth, 1894.

North Dakota Department of Agriculture and Labor, Bismarck. Report of Commissioner for 1894.

Missouri Botanical Garden, St. Louis. Report for 1894.

University of Iowa, Iowa City. Laboratory Bulletin, No. 3.

Auditor of North Carolina, Raleigh. Report for 1894.

Department of Health, Chicago, Ill. Report for 1894.

Florida Department of Agriculture, Tallahassee. Report of Commissioner for 1894.

New Hampshire Board of Agriculture, Concord. New Hampshire Agriculture for 1894.

Michigan State Board of Health, Lansing. Report for 1894.

Dr. J. A. Lintner, State Entomologist, Albany, New York. Bulletin of New York State Museum, Vol. 3, No. 13.

A. I. Root, Medina, Ohio. A B C of Bee Culture.

Maine State Board of Health, Augusta. Report for 1894.

Sir J. B. Lawes, Rothamsted, England. Memoranda of Origin, Plan and Results of Field Experiments at Rothamsted for 1894.

Prof. J. R. Hunter, Richmond, Va. Relation of the Anilides of Orthosulphobenzoic Acid.

Minnesota Horticultural Society, Minneapolis. Report for 1894.

Ontario Department of Agriculture, Toronto. Report for 1894.

Ohio Dairy and Food Commission, Columbus. Report of the Commissioner for 1894.

E. Willis, Charleston, S. C. Trade Review of Charleston, S. C., for 1894.

Thomas Sturgis, New York City. Proceedings of the New York Farmers for 1894.

Pennsylvania Hospital for the Insane, Norristown. Report on Bovine Tuberculosis. Clinical and Pathological Notes.

Wm. B. Phillips, Birmingham, Ala. Notes on Magnetization and Concentration of Iron Ore.

Massachusetts Horticultural Society, Boston. Transactions of Horticultural Society, 1894; part 2.

Department of Interior, Washington, D. C., (by courtesy of Hon. B. H. Bunn.) Eleventh Census. Churches. Indians. Selected Industries. Transportation by Water.

American Philosophical Society, Philadelphia, Pa. Report for 1895.

PAPERS AND JOURNALS OUTSIDE THE STATE, 1895.

Agricultural Epitomist	Indianapolis, Ind.
Agricultural Gazette of New South Wales	Sydney, Australia.
Agricultural South	Atlanta, Ga.
American Agriculturist	New York, N. Y.
American Dairyman	New York, N. Y.
American Farmer	Washington, D. C.
American Grange Bulletin and Scientific Farmer	Cincinnati, Ohio.
American Swineherd	Chicago, Ill.
Baltimore Sun	Baltimore, Md.
California Cultivator and Poultry Keeper	Los Angeles, Cal.
Carolina Planter	Florence, S. C.
Clover Leaf	South Bend, Mich.
Cotton Plant	Columbia, S. C.
Elgin Dairy Report	Elgin, Ill.
Farm and Dairy	Ames, Iowa.
Farm and Home	Springfield, Mass.
Farm and Home	Melbourne, Australia.
Farm and Fireside	Springfield, Ohio.
Farm and Orchard	Las Cruces, N. M.
Farm, Field and Fireside	Chicago, Ill.
Farm Journal	Philadelphia, Pa.
Farm Magazine	Knoxville, Tenn.
Farmers' Advocate	Burlington, Vt.
Farmers' Advocate	London, Ontario.
Farmers' Guide	Huntington, Ind.
Farmers' Home	Dayton, Ohio.
Farmers' Magazine	Springfield, Ill.
Florida Farm and Fruit Grower	Jacksonville, Fla.
Gleanings in Bee Culture	Medina, Ohio.
Grange Visitor	Charlotte, Mich.
Hoard's Dairyman	Fort Atkinson, Wis.
Home and Farm	Louisville, Ky.
Homestead	Des Moines, Iowa.
Horticultural Gleaner	Austin, Texas.
Hospodar	Omaha, Neb.
Industrial American	Lexington, Ky.
Louisiana Planter	New Orleans, La.
Mirror and Farmer	Manchester, N. H.

National Dairyman and Messenger	Kansas City, Mo.
Ohio Farmer	Cleveland, Ohio.
Oregon Agriculturist	Portland, Oregon.
Pacific Coast Dairyman	Tacoma, Washington.
Peninsula Farmer	Federalsburg, Md.
Practical Farmer	Philadelphia, Pa.
Progressive South	Richmond, Va.
Southern Cultivator	Atlanta, Ga.
Southern Farmer	New Orleans, La.
Southern States Magazine	Baltimore, Md.
Swine Breeders' Journal	Indianapolis, Ind.
Trade Journal	Baltimore, Md.
Wallace's Farmer	Ames, Iowa.
Weekly Times	Melbourne, Australia.

PAPERS INSIDE THE STATE, 1895.

Alamance Gleaner (Graham).
Asheville Citizen.
Beaufort Herald.
Caswell News (Yanceyville).
Caucasian (Raleigh).
Charlotte Democrat.
Charlotte Observer.
Chatham Record (Pittsboro).
Concord Standard.
Concord Times.
Davie Times (Mocksville).
Durham Sun.
Economist-Falcon (Elizabeth City).
Eastern Reflector (Greenville).
Elizabeth City News.
Franklin Press.
Free Press (Kinston).
Greensboro Patriot.
Headlight (Goldsboro).
Henderson Gold Leaf.
Hendersonville Times.
Mecklenburg Times (Charlotte).
Messenger and Intelligencer (Wadesboro).
Monroe Enquirer.
Monroe Journal.
Morganton Herald.
Murphy Index.
North Carolina Baptist (Fayetteville).
Patron and Gleaner (Lasker).
Press and Carolinian (Hickory).
Progressive Age (Aurora).
Progressive Farmer (Raleigh).
Roanoke News (Weldon).
Salisbury Watchman.
Stanly News (Albemarle).
Statesville Landmark.
Southern Poultryman and Dairyman (High Point).
Tarboro Southerner.
Tar Heel Poultryman (Shelby).
Union Republican (Winston).
Warrenton Record.
Washington Progress.
Washington Gazette.
Waynesville Courier.
Western Sentinel (Winston).
Wilkesboro Chronicle.
Wilson Mirror.
Wilson Times.

North Carolina Medical Journal (Wilmington).
Bulletin North Carolina Board of Health (Raleigh).

The New Poultry Division.

The Station has added during the latter part of the year another division to the several already in operation, known as the Poultry Division. It has long desired to commence operations in this particular line of work, and it is with much satisfaction that the work can now be commenced. The smaller industries of any state or nation are really those that prove of greater benefit to the masses. It is more easy to embark in them, on account of smaller capital and labor

required. Experience has shown that the multiplication of these industries gives better and more promising results than do a few large manufacturing or other plants that only benefit a limited section.

This will apply equally as well to agricultural industries. Poultry is one of these smaller industries, and can be conducted by almost every household with direct benefit to themselves, and as a prospective money crop when they are sufficiently able to supply the market with these productions. There is no sufficient reason why the various sections of this State should not produce and ship these products to other markets. By proper instruction in the care, management and shipment, it will not be long before valuable results will be reached. The large markets consume at high values all of the best poultry shipped to them, and we are sufficiently near for us to supply them from this State. It can only be a question of time before the proper methods for managing such a problem can be thoroughly communicated to those interested, before an important money crop can be added to our other diversified industries.

The relative amount of poultry raised in North Carolina, as compared with the whole country, can be seen below, as well as the quantity of eggs produced during the year preceding the time (June 1, 1890) when the data contained in the eleventh census was collected:

	In North Carolina.	*In United States.*
On Farms, June 1, 1890—		
Chickens	7,507,593	258,871,125
Turkeys	197.420	10,754,060
Geese	375.991	8,440,175
Ducks	169,409	7,544,080
Produced during 1889—		
Eggs (dozens)	11,755.635	819,722,916

In relation only to population, compared with the whole country, the State should produce fully twice as great a number of eggs as at present; and considering her other advantages, the increase should be many times as large.

As to the actual work that will be attempted, it can be roughly outlined as follows:

1. The employment of a suitable specialist to have the detailed charge of this division.

2. The procuring of various breeds of poultry, and by actual breeding tests to show the most desirable ones suited for the special object in view—whether for producing early

poultry for shipping, for egg production, for crossing on common stock, etc. The poultry yards have been located at the Experiment Farm, where they are at the same time convenient to visitors at the State Fair. Tests will also be made with the artificial hatching and raising of chickens.

3. The publication of educational bulletins will be inaugurated in this division to draw the attention of the people of the State to this important branch, and to suggest the best methods for taking care of and raising poultry, the diseases met with and best treatment for them, the best plans for shipping and marketing such products, etc.

The poultry manager who has been selected to be placed in charge of the division is Mr. F. E. Hege, a poultryman of large experience and of wide resources, formerly of the Riverside Poultry Farms of Newbern, N. C. He entered upon his work in December, on the farm of the Station adjoining the State Fair Grounds.

The Working Force at the Station.

The working force of the Station has been the same as in past years, with the following exceptions: Mr. B. W. Kilgore was granted leave of absence dating from October of the current year to June, 1896, for the purpose of pursuing adt vanced studies. Mr. S. E. Asbury, instructor in chemistry a- the A. & M. College, was temporarily employed to do chemical work in the laboratory of the Station during the above time. Mr. F. B. Carpenter resigned his position as second assistant chemist early in November, and the place has not been filled at the end of the present calendar year. In the poultry division newly organized, Mr. F. E. Hege of Newbern, N. C., has been employed as poultry manager, and began work December 1.

Farmers' Institutes.

The Station has aided the Commissioner of Agriculture in holding farmers' institutes in various portions of the State by sending, whenever possible, without detriment to the work in hand, some representative from its staff. It is believed that much good has resulted from these institutes, and that the time of the representatives has been wisely spent.

SOIL TESTS.

The Station has again attempted during the past year a series of soil tests in co-operation with farmers throughout the State, mainly old students of the agricultural college. The conditions surrounding the work are, however, so diverse, that coupled with the impracticability of sending a station representative to each locality to be present at important dates during the raising of the crops, the results have been inconclusive, and make it hardly advisable to continue the work during succeeding years.

A notable soil test with Irish potatoes was begun on the experiment farm with over 250 varieties, but unfortunately the bad weather conditions caused the crop to fail, and the results are of but little value.

TRUCKING INTERESTS.

The trucking interests of the State being of such great magnitude, a special publication was issued during the early part of the year, intending to give information upon every branch of the industry, and to embrace all of the crops that are usually grown or could be grown with profit. The subject of fertilizing was treated in detail, as ordinarily too little care is taken in reference to this very important part of crop growing. The subject of the use of glass for forcing early truck crops and for securing plants for early transplanting, also was fully discussed in this publication. The applications for this bulletin embraced all sections of North Carolina, nearly all of the Southern States, and many other states as well.

TOBACCO WORK OF THE STATION.

During the year, another publication was issued regarding tobacco. The types of tobacco grown throughout the United States in comparison with those grown within our borders were described and discussed, and careful and complete analyses of the leaf of each variety and type was made. The object was not only to determine their relative composition, but also to ascertain what ingredients were extracted from the soil by their growth. An improvement in the manner of making these analyses was instituted. It consisted in the separate analysis of the leaf independent of the midrib, and again of the midrib itself. Heretofore analyses have been usually made of the leaf portion alone, without consideration

of the midrib. In the analyses above referred to, the two portions analyzed were also combined in proper and relative proportions, and the analysis of the whole leaf was obtained as well as of the separate parts. The percentage of the midrib in the whole leaf varied from 17 to 34 per cent. The subject of burning quality was also carefully considered, and the relative burning capacity for each type was determined.

Educational Bulletins.

The Station has often had opportunity to see the very great value the system of educational or popular bulletins, which it inaugurated some years ago, has proven to the people at large, for whom they were written. As the name implies, the bulletins are free from technicalities as far as possible, and embrace subjects of practical and immediate value. They are written to meet the standpoint of the farmer who desires the subjects to be treated in a plain but comprehensive way, and such as will give him the exact information he desires, consistent with the many conditions, local and otherwise, which must be considered. The appreciation of such a series of publications is shown by the large number of applications, not only from our own State, but from other states and countries, as well as from the letters that are received and expressions that are heard regarding their value.

The system of press bulletins continue to be an important adjunct to the educational bulletins, in more widely distributing information of the subjects treated, as well as the general work also being conducted at the Station. The platematter plan for these press bulletins we regard of very great value, and cordially recommend it. Its operations have proved of such value that the columns prepared for this service have been reproduced in the regular bulletins of the Station in two instances during the year.

Dairy and Stock Interests.

To assist in furthering the dairy interests of the State, the Station has in the past year issued three bulletins relating to the subject, including the following: The Testing of Milk, including the Babcock milk test, the detection of adulterations in milk, buying and selling cows by tests of their milk, and the practical value of milk testing. Another bulletin treated of: Tests of dairy implements and practices, including the Berrigan, DeLaval, U. S. Hand and Victoria separa-

tors, the Cooley creamer, and the ordinary milk-setting system. A third bulletin discussed milk records and tests, including milk record at the Experiment Farm, variations of milk yield caused by variations in milking, and a test showing that cows are affected by changes in stable routine.

The result of feeding and digestion experiments for the year have been partially recorded in bulletin 118, descriptive of the work on cotton-seed hulls and meal for beef production. The digestion work on the more common feed stuffs has been continued, and will be presented in forthcoming bulletins. The object of this work will be to draw attention to the real value of these foods, either alone or in combination, and to the worth of certain rough stock foods that are now to a great extent allowed to go to waste.

Tuberculosis in Cattle.

Attention has been drawn to this subject by the publication of a bulletin on "Tuberculosis and its Prevention." Besides describing in detail the nature of this disease and its effect on the human family, through infection by means of milk, certain plans well tried and recommended by eminent authorities are given, which will tend to prevent the spread of this contagious and distressing disease. The bulletin also details the result of the examination of the Station herd, and one other herd in the State, with the use of tuberculin, which was kindly furnished by the Veterinary Division of the United States Department of Agriculture.

Hillside Ditching.

As such a large area of the State is hilly, being considerably more than one-half, and the question of preventing wasteful washes upon them of such great importance, it was considered that, if public attention was drawn to the fact that an easily-constructed system of ditching or terracing could be put in operation on every farm, that the publication of this fact might prove of great permanent advantage to a very large portion of the State. The construction of what is known as the Mangum hillside terrace was fully described and illustrated in a bulletin of the Station. The great advantage of this system is that crops can be planted and cultivated upon the terrace, which fact prevents the waste of land ordinarily caused by the usual hillside ditch, and also renders impossible the growth of weeds and other noxious growths which usually spring up along their sides.

Waldensian Colonists.

A few years ago a colony of Waldensians from the mountain regions of Italy was established in Burke County, about five miles east of Morganton, its county-seat. The colonists were an agricultural people, but thoroughly unacquainted with the conditions of crop growth in this State and in the section in which they settled. At their request, the Station sent a representative (Prof. W. F. Massey, its horticulturist) to visit the locality, examine their needs, and ascertain what course of treatment should be advised as to the crops to plant, rotation to pursue, and methods to adopt. In the outset the Station was hindered in transmitting such advice as was decided to give, by the fact that the colonists understood no English, and what was told to them was through means of an interpreter. In order to obviate this difficulty, it was decided to print a special bulletin embodying the advice thus offered, and give it in English alongside their native language. In this way the advice would be immediately given, and in addition the bulletin would also furnish a means for learning the corresponding phrases in English, so that they could become better acquainted with the language of the people in the midst of whom they had settled. The bulletin was issued in May, and was not intended to be a complete manual of agricultural instruction, but merely to give useful hints to aid them in their every-day operations.

The subjects treated were deep plowing, winter grain and crimson clover, plows, rotation of crops, and treatment of land. Growing wheat was also discussed, as well as the corn crop and subsequent rotation, Irish potatoes, cabbages for winter use, sweet potatoes, turnips, and early spring cabbage. The subject of taking care of home-made manure was treated as well as the recuperative crops. It is hoped that by this publication the Station has rendered assistance to the colonists, and helped to make their homes in North Carolina pleasant and their stay profitable.

Fruit Culture.

In several sections of the State the subject of fruit culture is of growing importance, and orchards of trees, vines and small fruits are being planted. In order to add another industry to those already within our borders, the Station has always striven to aid the industry, and has from time to

time published exhaustive bulletins for the proper planting, caring and gathering of these various fruits. The peach industry, promising to be especially remunerative, a bulletin of 36 pages was prepared and distributed, and a special spraying calendar was subsequently issued. The latter gave, in summarized form, the many formulas and modes of treatment which were more fully detailed in former publications. North Carolina has been remarkably exempt from many of the most troublesome insects and fungous diseases, but this immunity cannot be expected to be long continued, as experiences of other localities prove that these diseases and pests eventually, sooner or later, find a foothold in newer-planted localities. It is therefore all the more urgent that growers, in buying their stock for planting, use the greatest care in purchasing, and deal only with the most reliable nurseries, known to be free from all plant diseases and insect ravages. And if ever these diseases and pests do find a foothold, it will be their only salvation to fight them with the latest approved methods, and to do so in co-operation with each other, so that a united effort may in the beginning thoroughly stamp out the pests and prevent any further destruction. This is the only salvation for the fruit industry now so promising in several localities in the State. The Station, as always, has been ready to aid whenever occasion arises, and offers also to identify and prescribe remedies for any insect or disease which may be noticed by any fruit culturist.

Methods for Fertilizer Analyses.

The work of the fertilizer control is a very important part of the experiment station, and from the earliest time, attention has been given to all subjects relating to the fertilizer trade in the State and the most improved plans to secure greater accuracy in the proper conduct of the fertilizer inspection, not only in the actual drawing of the fertilizer samples, but in improvements to secure greater uniformity and accuracy in the analysis of the samples. In the past, special attention has been devoted to the methods for determining nitrogen in these analyses with much success, and a method which was brought forward by this Station is now one of the official methods of the Association of Agricultural Chemists, and was long used by this Station and by others. During the past year, through the labors of one of the chemists of the Station (Mr. Kilgore) who had served two terms

as reporter on phosphoric acid for the Association, there has been developed a method for the rapid estimation of phosphoric acid which promises to be accurate as well as saving of very considerable time. As there are three determinations of phosphoric acid in each fertilizer, and the method now used requires such extended time to finish a determination, the substitution of a convenient, accurate and short method would prove of great commercial and financial importance. The method spoken of was considered at the last meeting of the Association, and is now being studied by the several states having fertilizer control with the view of its adoption as one of the official methods of analysis.

Co-operative Horticultural Work at Southern Pines.

The institution of very important horticultural work is chronicled for the past year. This is co-operative investigations on the part of the N. C. State Horticultural Society, this Experiment Station, and the German Kali Works.

Early in the present year an offer was made to the State Horticultural Society by the German Kali Works to donate a sum for the purpose of conducting extensive tests upon the growth of orchard crops and other horticultural products. These Works represent the only potash deposits in the world, and they are desirous of ascertaining in what way and in what proportions, with other ingredients, potash should be used upon these crops. It will be recalled that potash is one of the three ingredients which is always present in a complete fertilizer, and one that the plant must have in order to obtain a vigorous growth and reach best maturity. The Horticultural Society, recognizing the great importance of the proposed work, accepted the proposition. The President of the Society is Mr. J. Van Lindley, of Greensboro, and the Secretary is Mr. Gerald McCarthy, Botanist and Entomologist of the Station. Its members are interested in horticultural pursuits, and are located in various sections of the State, and several of the Station's staff are members. The Society was confronted with the fact that they would be unable to carry on scientific work necessary in the proper management of such experimental tests, and they accordingly asked the co-operation of the Station in the proper management of the experiments in order to secure the best results possible in the work. A letter was received from the President of the Society asking the co-operation of the Station,

and a committee was appointed to wait upon the Station to ascertain in what way it could be secured.

The following extracts from the communication from the Society will further explain the nature of the proposed work:

"The North Carolina State Horticultural Society has completed an arrangement to undertake a joint experiment in growing fruits with chemical fertilizers on a commercial scale on naturally infertile soil situated in Moore county, N. C. This will serve as an object lesson to our own people and as an elucidator of what our State is capable of in this line to horticulturists from abroad. We believe very great and lasting benefit will accrue from this enterprise if carried out skilfully. To this end we respectfully solicit the co-operation of the N. C. Experiment Station. To carry out this experiment with the greatest economy, and to insure the utmost possible success, we need the counsel and practical assistance of experts in the various sciences concerned in plant-growth. It would be difficult, if not impracticable, for the Society to employ such experts on its own account. Inasmuch as the Station has regularly in its employ such men, and as the experiment is wholly for the public benefit, so far as the Society is concerned, we trust you will agree to co-operate with the Society in this matter. The Society is willing to make any convenient arrangement as to publication of the results, only giving due credit to all concerned."

In the reply to this communication, the following was sent:

"Regarding co-operation with the North Carolina State Horticultural Society in the conduct of the proposed experimental farm in the county of Moore, North Carolina, I have given the matter much thought, and have considered every phase of the subject. I believe the proposed work will, if properly managed, redound to the benefit of North Carolina, and especially to the horticultural interests within her borders. Such being the case, this Experiment Station will be glad to assist the Horticultural Society in conducting the proposed work, provided the accompanying conditions and propositions be accepted. In behalf of the Station, please allow me to thank the Society for the confidence in the work of the Station, implied by your request."

An agreement being decided on acceptable to all parties, the work was begun early in the year.

The following extracts from a preliminary announcement from the committee having the work in charge, will more

fully explain the details in connection therewith which will be of public interest:

1. OBJECT: The object of the work conducted on the Experimental Farm of the North Carolina State Horticultural Society is to ascertain: First, the relative proportion of the three principal fertilizing ingredients—phosphoric acid, nitrogen (and ammonia), and potash—needed by various fruit and vegetable crops for their best development; and second, to study the adaptability of the soil of this locality, which represents a large area in this state and adjoining states, for the growth of vegetable and orchard products, and also to study the best methods to accomplish these results. The clearing of the land was commenced February 18, 1895, and the trees and vines were first set out in the spring of that year. The vegetables are to be planted during the spring of 1896.

2. MANAGEMENT: The work is conducted by the North Carolina State Horticultural Society in co-operation with the North Carolina Agricultural Experiment Station, and the German Kali Works. The work is carried on under the auspices of the Society, the Experiment Station contributing the various scientific work in the horticultural, botanical, entomological, and chemical lines of the investigation, with the incident expenses; and the German Kali Works contributing financially towards the general expenses of the Farm. The Society and the Station are interested in ascertaining the best solution to the above questions for the benefit of the people of this state, as well as those living elsewhere. The German Kali Works are interested in the rational use of potash, as the only source of these salts of commercial importance is from their mines, and potash is a necessary ingredient in all complete fertilizers.

The direct charge of the work is in the hands of a Supervising Committee, composed of three members selected by the Horticultural Society, two members selected by the Experiment Station, and one member by the German Kali Works. The *personnel* of this Committee is as follows:

H. B. Battle, Director North Carolina Agricultural Experiment Station, Chairman.

J. Van Lindley, President State Horticultural Society.

W. F. Massey, Horticulturist North Carolina Agricultural Expeirment Station.

C. D. Tarbell, Member State Horticultural Society (resident member).

Gerald McCarthy, Secretary State Horticultural Society.

B. von Herff, German Kali Works.

3. LOCATION OF THE EXPERIMENTAL FARM: Moore County, North Carolina, was selected for the location of the Experimental Farm because it furnished the following advantages: The soil and climate had already been shown by actual trial to be adapted to the growth of fruit; and large areas of land could be selected with practically uniform soil containing but little quantity of plant food. The soil is accordingly the best kind for experimenting, as the presence of special ingredients is not likely to interfere with the general results. It represents large areas, and is therefore typical. It is practically level, which is of great value. A location could be secured which was never before cultivated or even cleared, consequently no previous treatment of crops, cultivation, and fertilization could interfere with it.

The farm consis s of two tracts [aggregating about 130 acres] which are located on account of the above reasons, near the town of Southern Pines, N. C., about one mile from its northern limits, and is easily reached by public roads, and also by the electric car line which is operated between the two noted health resorts of Southern Pines and Pinehurst. One of the tracts adjoins the celebrated Van Lindley peach orchard, which covers several hundred acres.

4. GEOLOGY, CLIMATE, AND SOIL: The geology of this region is similar to a large area extending from Maryland to Florida and beyond, and is made up of the eroded particles of older formations. The main formation here is the Potomac, although other formations are also found to a limited degree.

5. PLAN OF THE EXPERIMENTS: The experiments embody field tests with fertilizers upon an extended scale, both upon vegetables and and fruits. There are nine fruit crops, and eight vegetable crops, as follows:

Fruits.	*Vegetables.*
1. Strawberries.	1. Onions.
2. Blackberries.	2. Sweet potatoes.
3. Raspberries.	3. Cabbages
4. Grapes.	4. Asparagus.
5. Peaches.	5. Tomatoes.
6. Plums.	6. Snap beans.
7. Pears.	7. Cucumbers.
8. Apples.	8. Irish potatoes.
9. Chestnuts.	

The cultivation of each of the fruit crops embraces twenty-nine plats of one-tenth acre each, except that the small fruits of the first three series, have $\frac{1}{40}$ acre each, and each plat has a different application of fertilizing ingredients upon it. No commercial brand of fertilizer is used, and only fertilizing ingredients in different proportions are employed. Two plats in each series are left without any fertilizer, so that a fair average can be had of the capability of the soil without any artificial fertilizer, for comparison with other plats. The same general plan will be followed with the vegetable crops.

The work is thus upon a scale both extensive and complete, and the results will doubtless be watched with interest by fruit growers, truckers, and market gardeners here and elsewhere.

The Work of the Agricultural Division.

The work in this division has been continued in the lines already commenced and has been mainly in feeding, breeding, and digestion work with cattle and sheep, and in dairying. A portion of the work thus summarized has been concluded and published under the following titles:

Bulletin 113. The testing of milk.
114. Testing of dairy implements and practices.
115. Milk records and tests.
118. Cotton seed hulls and meal for beef production.

In the latter work, extended to a point not heretofore reached, beef stock were successfully fed for fattening purposes upon a ration of two pounds of hulls to one of meal, and

even one and one-half of hulls to one of meal. Furthermore the results are the more surprising as the health of the animals were maintained in their usual vigor throughout the experiment. The Station was one of the pioneers in conducting these tests of feeding cotton-seed hulls and meal for beef production, and for maintenance. The result of past work can be seen by reference to Bulletins 80 c, 81, 87 d, 93, 97, 106, and 109. In the experiments reported above, a very decided effect was noticed in the increase of digestibility of the hulls caused by contact with the meal in the ration. The definite result obtained was an increase of digestibility of carbohydrates of the hulls as compared with the hulls alone, and a small loss in the digestibility of protein due to the combination. The net gain of digestibility however was quite marked and increased the digestible dry matter from 0.81 per cent. in the broader ration, to 8.66 per cent. in the narrower ration of 3 of hulls to 1 of meal. The fertilizing constituents of the rations were accurately determined as well as those obtained in the manure, and it was shown that an average of 90 per cent. of the total manurial value was excreted in the dung and urine as compared with the original food. Of this 90 per cent., 42.5 per cent. was contained in the urine, and 47.5 per cent. in the dung. These figures show what is possible to be saved from such feeding, and how much is wasted if the proper care is not used to preserve it. They show also the very large proportion of value in the urine (amounting nearly to an equal amount) as compared with the solid excrement. How necessary it is, then, that the liquid excrement should be carefully saved and utilized for further use in growing crops.

The breeding experiments with cattle have embraced the breeding up of common cows by means of a thoroughbred short-horn (devon) of a milking strain. For this purpose a bull of good breeding has been secured, and it is expected that the grade stock obtained from this plan will prove useful and important additions to dairy and stock industry. Where milkers cannot be procured, the stock will be of sufficient size to warrant their being fattened and sold for beef, or else utilized for work animals.

The breeding experiment with sheep continues, and the crosses that are being made are with common ewes and thoroughbred rams, horned-dorset, merino, shropshire, and southdown.

The digestion experiments with sheep have included stud-

ies on the more common feeding stuffs, such as timothy hay and cotton-seed meal, crab-grass hay, cut corn-stalks, etc.

The agriculturist, besides attending several of the farmers' institutes conducted during the year, has been of material aid in forming and conducting the State Dairymen's Association, and the Swine-breeders' Association. His aid in the correspondence of the Station upon agricultural subjects has been of marked value and importance.

The usual farm operations have been conducted on the farm, the soil and locality of which prevent the trial of soil tests with fertilizers or varieties. During the year eight tests were instituted in various portions of the State, and mainly with former agricultural college students.

The Work of the Chemical Division.

A large proportion of the time of this division has been devoted to the fertilizer control. In order to make the value of this work more complete, the analyses are made very promptly on receipt of the samples from the official inspectors. The publications by this means are thus printed and distributed in time for the buyers of fertilizers to use them in their purchases. A very complete equipment is thus required, which embraces all apparatus and reagents for the handling with rapidity the several determinations of a fertilizer analysis. The usual analysis includes: three forms of phosphoric acid, nitrogen or ammonia, potash, and moisture. Oftentimes duplicate and triplicate determinations are necessary, which very largely increase the quantity of work. The number of chemists has also been increased, so as to finish the analyses as soon as possible. In addition to the official samples, such other samples of fertilizers have been analyzed that have been sent in by farmers, and sampled after instructions received from the Station. It is not necessary that the name of the brand be sent with the sample, but it must be given to the Station after the analysis is completed and furnished to the sender of the sample.

In addition to fertilizer samples, others of natural fertilizing ingredients, marls, phosphates, mucks, composts and home-made mixtures, cotton seed and its products, etc., have been made. Such of the work of the other divisions demanding chemical examination has also been done. Prominent among them have been the stock digestion work in cooperation with the agricultural division, in which much

time has been devoted. During the year the chemical work in this connection has been more complete than before, and has included, together with the digestion of the several foods and combinations, the proportions of the fertilizing ingredients recoverable in the manure.

The division has also been of material aid in the operations of the field work at Southern Pines with fertilizers on horticultural crops as elsewhere described. The time of one chemist for a portion of the year has been almost constantly devoted to this work. The tobacco work of the past has been continued and extended to include the examination of many types of tobacco grown in various parts of the United States in comparison with home-grown varieties. The result has been published during the year.

The study of the best chemical methods for analysis has continued, not only in connection with the various reporters of the association of official agricultural chemists, but independently, and with very promising results. The work on the determination of phosphoric acid in fertilizers and soils has been issued in one of the bulletins of the Station.

During the year, among others, were analyzed 359 samples of fertilizers, 24 fertilizing ingredients, 11 samples for fertilizer methods, 64 health waters, 62 mineral waters, fodders 23, and 128 ores and minerals identified.

The Work of the Botanical and Entomological Divisions.

A bulletin on "Parasites of Domestic Animals" has been in preparation, and is almost ready for the printer. Another has been prepared on "Insect Pests of Garden Vegetables." The work of identification of specimens and effects of fungous diseases has continued, and statements regarding the utility or noxious quality have been promptly returned to the sender. In field work, twenty-seven varieties of cow-peas have been on trial, and also other forage plants, including importations from Japan, Australia, and Italy. Of the best varieties of cow-peas, including the "Wonderful" or "Unknown" variety, and the "Red Ripper" variety, 350 half-pound packages were distributed to applicants for trial in different parts of the State. In this way the merits of these varieties of important forage crops have been studied by the applicants, and the value, in comparison with the common seed, has been shown. The division has also been of benefit in assigning true values to the various grasses and plants

which are almost annually brought out by seedsmen, with exorbitant claims as to their utility. The botanist has also rendered valuable aid in connection with the State Horticultural Society in keeping its work alive and before the public and calling attention to the horticultural possibilities of this State. During the year and in the past, two valuable reports have thus been issued by the Society, almost entirely through his efforts. Much of the time of the botanist and entomologist has been required in connection with horticultural work at Southern Pines.

The subject of fibre plants has also received some attention, and several varieties, including jute, have been studied. If a successful machine can be obtained that will extract the fibre from the plant after growing, it is likely that the culture of this plant may assume some importance. It is generally known that the jute so largely used in the manufacture of cotton bagging is raised in India and is imported to this country via Dundee, Scotland. The twine and bagging is made in the fibre mills of St. Louis, Mo.

The Work of the Horticultural Division.

A field test of a very considerable number of varieties of Irish potatoes was conducted during the year, but unfortunately the seasons proved so disastrous that the result was incomplete and not conclusive. The work heretofore done on the growing of flowering bulbs for commercial sale has been continued, with very satisfactory results. It includes all the more common bulbs, such as Roman hyacinths, lilies, narcissi, gladioli, tulips, freesias, etc., most of which are now imported in large quantities from Holland and Bermuda. This work has attracted considerable attention, and large importers look upon it with much favor. The bulbs grown here and in this State have compared most favorably with foreign-grown bulbs, and in many cases are superior to them. In addition, it has been proved that these bulbs can be forced under glass. It is very probable that a remunerative industry may be the result of this investigation. A bulletin has been issued during the year on "Trucking Crops in the South," which has received wide appreciation. Another is in preparation on the growth of garden vegetables for home use, which will be issued during the coming year. The division has necessarily been of great service in the conduct of the horticultural work conducted at Southern Pines, and

most of the horticultural work of the Station will likely be transferred to that point in the future, as it has become necessary in the conduct of the co-operative work there, that the assistant horticulturist be present there for a large portion of his time.

The Work of the Meteorological Division (State Weather Service).

This division has been conducted as in the past with the co-operation of the U. S. Weather Bureau, and two of its observers are located at this point, and assist in the conduct of the Weather Service. The publications of this division have been continued as in the past. They embrace the monthly meteorological bulletin, which includes observations of the weather observers in various parts of the State. There are sixty-six of these, fifty of which send complete reports, and sixteen partial. Copies of these bulletins are bound with the annual report of the Weather Service, issued at the end of the year. The weekly weather crop bulletins were also sent out as usual, 27 numbers being distributed during the growing season. There were 350 reporters, representing all of the 96 counties. The number thus being enlarged and widely distributed, the value of the summary of these reports has consequently increased over former years. These bulletins are sent out immediately after the receipt of reports from these reporters, so that no time is lost. The daily forecasts were distributed as in the past, and 44 stations receive telegraphic warnings of the condition of the weather for the following day, and the approach of cold waves and the occurrence of frost. By the distribution of cards through the mails and weather maps, 264 additional places are reached, and with the logotype system in distributing the forecasts from nine centers, 178 additional offices are reached. Counting all methods 583 points, including the surrounding localities, are provided with indications showing the probable state of the weather for the ensuing twenty-four hours.

The Work of the Veterinary Division.

In conjunction with the agricultural division, a bulletin has been issued upon the subject of "Tuberculosis." It details the results of the tests upon the Station herd with tuberculin, together with a similar test conducted at another point in the State. A popular discussion of this disease, and how to prevent its infection and spread, are also inserted in the publication.

A disease among the horses in the extreme eastern part of the State, which seemed to be of an infectious origin, occurred during the year. It was investigated by the veterinarian, with the result that it was pronounced pleurisy, caused by exposure. Remedies for the proper treatment were suggested, as well as methods for future prevention.

The Work of the Poultry Division.

Active work had hardly begun at the expiration of the current year, consequently only preliminary statements can be given at the present time. These have been already outlined in the previous pages, and need not be repeated here. It is expected that the work of this division will prove of great advantage to different sections of the State, and that poultry raising and other industries connected with it may, on account of its establishment, be greatly extended, and consequent beneficial results will accrue.

REPORT OF THE AGRICULTURIST.

DR. H. B. BATTLE, *Director.*

SIR: During the past year, this division has carried forward the feeding and dairy records as indicated in bulletin 116, which has been issued within the year. This also gives summaries of the previous records made, together with notes on the cows in the herd. It is believed that the outbreak of abortion has been suppressed and that calves can now be bred. To this end and for the purpose of carrying forward the trial of grading up native and grade stock with the dairy short-horn, another bull has been purchased and his use begun. The cows and heifers now in the herd have made records for themselves and it remains to secure from as many of them as possible female progeny in order to test the value of this line of breeding, by showing better or poorer qualities in offspring than the dams possess. Others have and are testing the relative merits of pure bred animals of the various breeds of cattle for milk, butter, cheese, and beef. This is well, but the great majority of farmers must for a long time be content to breed and feed common stock, or to grade up common stock by use of pure service bulls. We believe the breeding of the older importations of short-horns has done more for the improvement of the common stock of the country than any, and perhaps all other breeds, and that it should be fostered and encouraged. To this end and to help those most needing the example and encouragement, we have led off in this at present not very popular line. Those who can afford pure bred cows, and special-purpose stock are not expected to be disturbed; but we wish to urge those who cannot do this, to try the kind of cattle which make of the well-fed progeny, animals fit for work, for the dairy or beef, and which rank close up to, if they do not equal, the special-purpose stock in their own special lines of productions. With the new bull, if epizootic abortion is now eradicated, we have again made a strong start, and hope to see success rest on this effort.

Of the sheep purchased a year ago, the Horned Dorsets, the offspring and one ewe have died. The Merinos were

merely lambs when purchased. They are thriving and one of the ewes has yeaned a lamb which is doing well. During the fall, a trio of Shropshire sheep has been purchased of Occoneechee Farm. These are fine sheep, and are doing well. A trio of Southdown sheep has also been purchased in Pennsylvania, but only the ram has arrived. He is a good lamb and is also doing well here. The native ewes purchased have brought forth a satisfactory number of young, and most of them are thriving as well perhaps as could be expected after so hot and dry a season, when they were obliged to pick most of their own living from very short pasturage.

A feeding experiment with four cows in milk, conducted to test rations prepared for a correspondent, occupied considerable time last winter, and part of it may be repeated this winter.

Digestion experiments were resumed again last July, and have been continuously conducted ever since to test the effect of cotton-seed meal on the digestibility of timothy hay. At this writing the results are not calculated far enough to report; but so far as seen, the indications are that the results obtained by similar feeding and digestion with corn silage and with cotton-seed meal, will be supported by this series when completed.

It is expected that a few more southern cattle foods, which have never yet been subjected to digestion experiments, will be thus treated and their values determined this winter.

The bulletin No. 109, issued the latter part of last year, was well received, and the quotations and kind words from the agricultural press have brought calls for it from a considerable number of States. The subject of pig feeding especially, has become one of increasing interest among our correspondents.

The correspondence from this division has not decreased in interest or volume during the past year. The press service bulletins serve to show something of the character of it, yet much is of too special a character to be thus used. Through this means, this division has endeavored to be of assistance to the dairy interests outside of the usual channels by aiding in the organization of the N. C. State Dairymen's Association, and by giving information to associations of farmers who desired to establish co-operative creameries, and in preventing them from purchasing high-priced outfits and useless machinery.

Field experiments have included a successful seeding with

timothy and other grasses from November, 1894, seeding. We have cut timothy hay this year from that seeding, and if the bulbs have survived the September heat, and drought no one need go outside of North Carolina to raise timothy hay if he will enrich his land enough to grow it well. A soil test with the black cow-pea has also been concluded. Soil tests have also been conducted under our supervision as follows, many of them being former students of the A. & M. College:

M. W. Buffalo, Raleigh, with tobacco.
S. D. Coley, Raleigh, with tobacco.
W. A. Meacham, Raleigh, with corn.
L. A. Cowper, Gatesville, with corn.
C. W. Gold, Wilson, with cow-peas.
C. B. Foy, (Glenoe Stock Farm), Verona, with corn.
B. W. Hawkins, Horse Cove, with corn.
R. D. Patterson. Jr., Durham, with corn.
T. B. Wetmore, Woodleaf, with corn.

The improvements during 1895 have embraced:

Painting and some repairs on the cottage.
One coat of paint on the office building.
Some repairs and ventilator on the dairy.
Coat of paint on all roofs.
Bridge at the barn has been renewed and yard graded.

Yard fence for stock has been placed around the barn with gates at convenient points, and old grass plats turned into a yard.

Drainage for north-east slope of dairy has been provided for by a drain to discharge below the barn tank.

Sink drain from office has been continued from three feet outside of the wall to a well of stone which extends to the drain from the cellar to some distance across the field.

F. E. Emery, *Agriculturist.*

REPORT OF THE FIRST ASSISTANT CHEMIST.

DR. H. B. BATTLE, *Director.*

DEAR SIR: I present herewith a report of work in the chemical division of the Experiment Station for the year 1895. There have been made analyses of—

Commercial fertilizers	359	Brought forward	395
Cotton-seed meal	7	Young cow-pea plants	1
Cotton-seed hull ashes	1	Slaked lime	1
Ashes	1	Fertilizer material	1
Plaster	1	Fossil coral	1
Marl	8	Ores	2
Tobacco dust	1	Boiler water	1
Soil	2	Health waters	64
Soil, reporter's samples	4	Mineral waters	62
Reporter's samples for potash	2	Milk	1
Reporter's samples for nitrogen,	2	Fodders	3
Reporter's samples for phosphoric acid	3	Fodders in connection with digestion experiments	20
Sulphate potash	2	Urine	1
Pine straw	1	Ores, minerals, and rocks identified and values reported	128
Cow-peas	1		
Carried forward	395	Total	681

In addition to the work involved in the above analyses, the workers of this division have devoted some time to the study of methods used in these analyses. We have taken part in the study of methods for determining phosphoric acid, potash, nitrogen, and for soil analysis, for the association of official agricultural chemists. The undersigned was the reporter of the above association on phosphoric acid and devoted considerable time in securing data and preparing a report on the subject. This report has been published in a bulletin from the chemical division of the United States Department of Agriculture.

Digestion Work.—A bulletin embodying the results of the fourth year of progress in determining the digestibility and feeding value of North Carolina feeding stuffs has been prepared by this and the agricultural division. This completes our investigation for the present of the digestibility of cotton-seed products and rations of them, and includes also a consid-

eration of the effect of cotton-seed meal upon the digestibility of cotton-seed hulls and other coarse foods. Several experiments have been completed, and others are now under way for determining the digestibility of rations of cotton-seed meal and hays, and if possible the effect of each upon the digestibility of the other.

Publications.—In addition to the bulletin on digestion work, a bulletin on the Estimation of Phosphoric Acid, embodying the results of considerable work done from time to time during the past two years, has been prepared and published. This bulletin is devoted mainly to an investigation and development of the volumetric method of determining phosphoric acid by titrating the ammonium phosphomolyb date precipitate with standard alkali.

The Experimental Farm of the State Horticultural Society.—This division assisted in laying out the plots and putting out the plants on the farm at Southern Pines, and fertilized them, and in addition made analyses of all fertilizing materials used.

Equipment.—The laboratory is in very good equipment for the work before us, and will only need the necessary chemicals and apparatus for the usual investigations.

In conclusion, I desire to say that the work of the division is shared as nearly equally as possible by the different analysts, each man devoting his time as far as possible to special lines, and to each is due corresponding credit for the work accomplished.

Respectfully submitted,

B. W. KILGORE,
First Assistant Chemist.

REPORT OF THE BOTANIST AND ENTOMOLOGIST.

Dr. H. B. Battle, *Director*.

Sir: I have the honor to make the following report of the working of the Botanical-Entomological Division of the Station for the current year of 1895:

A bulletin on "Parasites of Domestic Animals" has been prepared and has been ready for the press for some time, except as to the cuts which had to be ordered from Europe. This will comprise a very elaborate and detailed treatment of the most important worm and insect parasites of cattle, horses, mules, sheep, goats, hogs, dogs, cats and poultry, together with most appropriate remedies for the same. No such work is at present available to farmers, and it is hoped that this will fill an acutely-felt need.

A bulletin on "Diseases of the Peach Tree" has also been prepared and is now in press. This bulletin was called forth by the personal observations of the writer in the principal fruit-growing districts of the State. During the fruit season of 1895 the peach crop was about the only one that returned a good profit to the grower. Although peaches were formerly grown for the market to a considerable extent in North Carolina, the industry gave way some years ago to grape-growing, which crop is less troublesome to grow and formerly yielded better returns than peaches, because the Delaware growers then commanded the peach markets of the country. Of late, the grape industry has been somewhat overdone, and growers have again commenced to plant peaches. Those who have planted the most suitable varieties and taken reasonably good care of them have realized such profits as will likely extend further the peach growing industry during the next few years. The peaches shipped from North Carolina this year have brought the highest market rates paid for extra fancy fruit. But no industry is without its drawbacks, and the recent multiplication of peach orchards has also introduced and multiplied the parasitic enemies of this fruit. The much-dreaded disease, "peach yellows," which has caused such devastation in the

once-renowned orchards of the Delaware peninsula, has hitherto been absent from our State, but unless our peach growers are more careful than they are at present, our immunity will not long continue. Several new and destructive peach parasites have already been detected in peach orchards just coming into bearing.

All these are described, illustrated, and remedies prescribed in the bulletin now in press.

In addition to the above, the botanist and entomologist has contributed a number of papers to the press bulletin service of the Station, and other papers to different agricultural journals and meetings.

The plats at the Experiment Farm devoted to testing new grains, forage and economical plants, have been removed to a drier and higher location so as to more nearly approach the average cultivated soil of the State. Many new plants have been under observation this year, but the season has been so abnormal that results so far are not of general application. The greatest success of the year has been with jute. The seed of this plant was sown in the drill in the field early in May. Notwithstanding the cold, wet and late spring, the plants gave a good stand, held their foliage well through the long, severe drought, grew about seven feet high, and finally ripened seed, thus completing the cycle of growth. That this crop should do so well under the extremely unfavorable weather of the past summer shows in a most emphatic manner that with intelligent management, jute can be made one of the staple agricultural products of this State if a convenient machine for stripping the fibre from the plant can be secured, which now seems likely. While our past season's experiment shows that this plant can be successfully grown on rich upland loams, yet it is by nature a moist land plant, and will give best results on rich river bottom fields. At present ship-loads of the dried stems, known in commerce as "jute butts," are imported into this country from India *via* Dundee. It is manufactured into cotton bagging chiefly at St. Louis, Mo. There are some ten or twelve factories engaged in the trade.

During the past year, a very considerable part of the time of the botanist and entomologist has been occupied by field work at Southern Pines, N. C., in connection with the Experiment Farms of the State Horticultural Society there located. The work there begun is on a very extensive scale, and if carried out according to present plans, it must have a far-

reaching influence on the horticultural interests of the State. During the present year, the work of note-taking and spraying has fallen wholly upon the Station Botanist and Entomologist, and has proved extremely onerous.

For the coming year it is suggested that this division make a specialty of the jute plant—growing the plants and distributing them where most likely to succeed. In order to ensure success, it will be necessary to give personal advice and attention to their growth. A bulletin on the subject, with all possible details, illustration of machinery, etc., can be prepared if this investigation be continued. The experimental plots at the Farm should be continued and new plants tested. A bulletin on enemies of garden and truck crops will be ready by March 1, and one on those of grain crops later. A bulletin on medicinal plants has been begun, but this subject will require another year's study and observation of growing plants.

Very respectfully,

GERALD McCARTHY,
Botanist and Entomologist.

REPORT OF THE HORTICULTURIST.

Dr. H. B. Battle, *Director*.

I beg leave herewith to submit my report of the operations of the horticultural division for the season of 1895.

Owing to the constant inquiries as to varieties of the Irish potato from various parts of the State, it was thought advisable to attempt a test of a large number of varieties the past season, so that some data could be had from which advice could be given as to the best sorts for our climate. Over 250 varieties were procured and planted, but partly owing to the exceedingly wet and cold spring weather and partly to the fact that many of the samples procured from the north were in a badly weakened condition, a large portion of them failed to grow at all, but rotted in the ground, and the result with the remainder was so unsatisfactory that no conclusions of any value could be arrived at from the trial. I do not think it advisable to renew the test with an equal number of sorts, but there are a number of varieties that may prove to be of value, and we propose to make a further trial of these another season.

One new variety of late potatoes from Georgia promises to be a valuable acquisition, and we have secured from the crop of this season enough for a more complete test during another season.

The experiments in the culture of flowering bulbs have been continued with gratifying results. Messrs. Peter Henderson & Co. sent us last fall a large lot of bulbs of different kinds for the purpose of testing their growth here, they paying the freight both ways and we returning them an equal number of bulbs. The natural increase in the lilies was not large in one season, while the narcissi increased very rapidly. The bulbs when returned to New York, after one season's growth here, excited a great deal of interest, and the *Garden and Forest*, the leading horticultural paper of New York, stated that they were far superior to any imported bulbs, and that it only remained to see whether they would force under glass as well as the imported ones. We have

heretofore tried some of them successfully, and the present winter will force some of all the bulbs we have grown, so as to be able to speak authoritatively upon this point. We are more than ever satisfied that in the near future the culture of these bulbs will develop into a remunerative industry in North Carolina.

In fruits, the chief work that has been done this season has been the fruiting of a large number of seedling grapes, grown by Mr. Munson, of Texas. While most of these are remarkable for great vigor and healthfulness of vine, there are few of them that promise to be of any greater value than varieties we already have. We will give them one more season's test before reporting finally on the varieties, though it seems evident that few of them possess sufficient value to make them worthy of culture here. The work with bulbs will be continued next season, and we wish to renew the study of the tomato, which was interrupted this season by the extent of the planting of potatoes. Some seedling grapes of our own growth should give fruit next year, and we are hoping for something good from them.

All of which is respectfully submitted,

W. F. MASSEY,
Horticulturist.

REPORT OF THE METEOROLOGIST.

DR. H. B. BATTLE, *Director*.

DEAR SIR: In compliance with your request, the following brief report of the operations of the North Carolina State Weather Service during the past year, is submitted.

Meteorological Observers: Reports have been received during the year from sixty-six voluntary meteorological observers, of which number fifty have rendered complete data, and sixteen only partial records. This indicates a very high percentage of faithful and painstaking observers. The number of changes during the year have been relatively few. Four stations were established, namely, at Armour, Rutherfordton, Salem, and Settle. Five stations have been discontinued, namely, Armour, Erie Mills, Bailey, Marion and Shelby. From the last two named, though not yet officially discontinued, no reports have been received since May, 1895.

Instruments have been ordered for equipping stations at Edenton, Monroe, and Jefferson—all important points, filling out vacant sections in the State. The Chief of the Weather Bureau has informed this office that the instruments would be shipped in time to commence observations by January 1, 1896. The establishment of stations at Beaufort, Jacksonville, Sparta, and Troy, is also contemplated. This work of establishing new stations cannot cease until at least every county is represented.

The reports of voluntary observers are, as a rule, very reliable. The data has been published as usual in the monthly bulletins, under the title, "North Carolina Weather During ----." The number of the last monthly bulletin—that for October—is 73. In the early part of the year, the Eighth Annual Report for 1894 was issued. Of the monthly bulletins 1,800 copies are printed, of which 500 are distributed immediately, and 1,300 are reserved for binding with the annual reports.

Forecast Display Stations: The year opened with 64 display stations, receiving forecasts by telegraph at government expense, and generally also supplied with flags by the Na-

tional Weather Bureau. This number could only be kept up because forecasts were telegraphed conditionally, that is no telegrams were sent when the forecasts were for fair weather, stationary temperature; but upon the appointment of the new Chief of the Weather Bureau, Prof. Willis L. Moore, on the first of July, 1895, a return was made to the older method of issuing weather forecasts by telegraph regularly every day. As, however, by the method, the fund for telegraph expenses of the Weather Bureau was rapidly exhausted, the number of display stations at the beginning of November was lessened to 44. The 20 discontinued are chiefly those which could almost as readily be reached by mail, hence it is believed that the interests of the public have not suffered. On the other hand, the number of places receiving weather forecasts by mail has considerably increased.

Forecasts by mail are now being distributed by the logotype system from thirteen places in the State, as follows:

From Charlotte, N. C., to 20 postoffices.

From Norfolk, Va., to 13 postoffices in North Carolina.

From Raleigh, N. C., to 264 postoffices.

From Wilmington, N. C., to 54 postoffices.

Also—

From Mocksville, N. C., (Will. X. Coley, displayman,) to 27 places.

From Nashville, N. C., (J. H. Collins, displayman,) to 5 places.

From Rutherfordton, N. C., (J. W. Harris & Son, displaymen,) to 11 places.

From Winston, N. C., (S. H. Smith, displayman,) to 7 places.

From Tarboro, N. C., (E. W. Rawls, displayman,) to 38 places.

From Lenoir, N. C., (Jno. W. Kirby, displayman,) to 14 places.

From Connelly's Springs, N. C., (J. W. Dorsey, displayman,) to 18 places.

From Sanford, N. C., (J. W. Scott, displayman,) to 39 places.

From North Wilkesboro, N. C, (J. S. Forester, displayman,) to 19 places.

Total number of points receiving forecasts by telegraph and mail in North Carolina is, therefore, 573.

Weather Crop Service: The issue of the Weekly Weather

Crop Bulletin was commenced April 9th, and the last issue (No. 27) appeared on October 7th, and contained a review of the crop season for the year. The steadily increasing demand for the crop bulletin required an edition of 1,850 copies. The number of crop correspondents was about 350, representing all the counties of the State. The crop bulletin is in appearance and substance fully equal to the best bulletin issued by any State Weather Service, which has a direct appropriation from the state.

There is contemplated during the coming year a further extension of the mail distribution of weather forecasts by the logotype system, or by the method recently suggested at the Fourth Annual Convention of State Weather Services—the post-mark logotype system—which will ensure the printing of the weather forecasts on every piece of mail matter delivered by the larger postoffices. The net-work of voluntary observing stations is to be extended. Material enough will soon be available for some special investigations relating to climate and crops, etc., which may be prepared and published in the monthly or annual reports. Few state weather services have as yet undertaken to make the meteorological materials being collected practically useful, but the recent special bulletin issued by the Texas weather service, "Climate of Texas in relation to the Cultivation of the Olive," is an earnest of what may be accomplished in this respect as soon as sufficient material has been collected.

Very respectfully,

C. F. von Herrmann.

North Carolina Agricultural Experiment Station

IN ACCOUNT WITH

The United States Appropriation.

1895.			*Dr.*
	To receipts from the Treasurer of the United States as per appropriations for the year ending June 30, 1895, under Act of Congress approved March 2, 1887		$15,000 00
		Cr.	
June 30.	By salaries	$6,142 97	
"	labor	868 13	
"	publications	4,137 27	
"	postage and stationery	592 94	
"	freight and express	186 40	
"	heat, light and water	299 11	
"	chemical supplies	377 01	
"	seeds, plants, and sundry supplies	381 01	
"	fertilizers	48 01	
"	feeding stuffs	384 77	
"	library	180 09	
"	tools, implements, and machinery	90 21	
"	furniture and fixtures	439 07	
"	scientific apparatus	150 04	
"	live stock	12 72	
"	travelling expenses	204 46	
"	contingent expenses	267 37	
"	building and repairs	238 42	
	Total		$15,000 00

The undersigned, duly appointed Auditor for the State Board of Control, hereby certifies that the above items of expenditures, made by the North Carolina Agricultural Experiment Station for the fiscal year ending June 30, 1895, are made up from the books of the Auditor of the Board and of the Treasurer of the State of North Carolina (Treasurer of the North Carolina Agricultural Experiment Station), and that the receipts from the Treasurer of the United States for the year named were $15,000, and the disbursements $15,000, for all which proper vouchers are on file in the office of the Treasurer above named.

(Signed) T. K. Bruner, *Auditor.*

I hereby certify that the foregoing statements, made up from vouchers on file in this office, to which this is attached, is true and in accordance with the records of this office.

(Signed) W. H. Worth,
Treasurer of North Carolina Agricultural Experiment Station.

The above are the signatures of the Auditor and Treasurer of the North Carolina Agricultural Experiment Station.

(Signed) H. B. Battle,
Director of North Carolina Agricultural Experiment Station.

Fertilizer Analyses

of the Fertilizer Control

INCLUDING OFFICIAL ANALYSES OF SPRING AND FALL SAMPLES OF 1894.

ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

BULLETIN NO. 111

JANUARY 12, 1895.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

STATION COUNCIL.

A. Q. HOLLADAY, *Pres. A. and M. College.*
W. S. PRIMROSE,
H. B. BATTLE.

OFFICERS OF THE EXPERIMENT STATION.

H. B. BATTLE, PH. D..............................Director and State Chemist.
F. E. EMERY, M. S..............................Agriculturist.
GERALD MCCARTHY, B. SC..............................Botanist and Entomologist.
W. F. MASSEY, C. E..............................Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau)........Meteorologist.
F. P. WILLIAMSON, D. V. S..............................Consulting Veterinarian.
B. W. KILGORE, M. S..............................Assistant Chemist.
F. B. CARPENTER, B. S..............................Assistant Chemist.
W. M. ALLEN..............................Assistant Chemist.
C. B. WILLIAMS, B. S..............................Assistant Chemist.
ALEXANDER RHODES..............................Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau)..............Assistant Meteorologist.
A. F. BOWEN..............................Secretary.

RALEIGH, N. C.

FERTILIZER ANALYSES OF THE FERTILIZER CONTROL

INCLUDING

OFFICIAL ANALYSES OF SPRING AND FALL SAMPLES OF 1894.

BY H. B. BATTLE, DIRECTOR.

As has been frequently stated, the work of the Station lies under two heads:

1. The Agricultural Experiment Station.
2. The Fertilizer Control Station.

THE FERTILIZER CONTROL STATION.

The present bulletin is issued in the interest of the latter, and presents to the people of the State the analyses of samples of fertilizers taken both in the spring and fall season of 1894. It is issued before the opening of the spring season of 1895, in order to give the relative standing of all brands of fertilizers sold in the State, so far as they have been found and sampled. This bulletin is published before the movement in fertilizers has begun for 1895, with the view of affording to purchasers means of judging of the standing of any given brand during the past seasons.

Analyses for 1895. As is known, the samples of fertilizers are taken by the official inspectors from fertilizers after they have been sent into the State, and are out of the hands of the manufacturers and in the hands of local dealers. These samples, therefore, represent exactly what the purchasers are getting. Samples are taken throughout the season by the different inspectors in various portions of the State. Analyses are made very promptly upon receipt of samples from the inspectors, and prepared for publication with the least possible delay. As in past years, they will be printed every two weeks during the fertilizer season of 1895. These bi-weekly bulletins are sent only to those who request them, but one application only is required for the entire season.

The Present Fertilizer Laws. The following carefully prepared digest shows accurately, in small compass, the existing laws in regard to fertilizers. It is intended to give information in regard to the fertilizer trade which should be known by purchasers, dealers, and the public generally.

No manipulated guanos, superphosphates, commercial fertilizers or other fertilizing material shall be sold or offered for sale unless a tonnage charge of twenty-five cents per ton has been paid. Each barrel, package or bag shall have attached a tag representing this fact, which tags shall be issued by the Commissioner of Agriculture according to regulations prescribed by the Department of Agriculture. The Department of Agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least ten per cent. of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufactories, and accordingly represent the true grade of fertilizers offered for sale.

Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the Commissioner of Agriculture, together with a true sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. This label must set forth the name, location and trade-mark of the manufacturer; also the chemical composition of contents and real percentage of the ordinary ingredients claimed to be present, together with date of analyzation, and that all charges have been paid. There must be no variation in the guaranteed percentages, but the bags must be branded with the exact chemical composition of the contents. No fertilizer can be sold with a content less than eight per cent. of available phosphoric acid, two per cent. of ammonia, and one per cent. of potash. Cotton-seed meal is exempted from paying the tonnage charge; also land plaster, agricultural lime, oyster-shell lime, marl, and bulk materials for manufacturing purposes, upon which a tonnage charge is to be paid thereafter.

It is a misdemeanor, and a fine of ten dollars for each bag, for an agent or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or a railroad agent to deliver it. Goods kept over from last season must be tagged to represent this fact, and all dealers are required to report to the Commissioner of Agriculture the amount on hand at the close of the fiscal year, on November 30.

Any fertilizer or fertilizing material that does not contain the ingredients as represented by the label is liable to seizure, and, after being established on trial, its value is recovered by the Board of Agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law, is liable to a fine of ten dollars for each separate package—one-half, less the cost, going to the party suing, and the remainder to the Department; and if such fertilizer is condemned, the Department makes analysis of the same and has printed labels placed on each package, giving the true chemical ingredients of the same, and fixes the commercial value at which it may be sold. The Department of Agriculture can require agents of railroads and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The Experiment Station analyzes samples of fertilizers taken by the official inspectors, and publishes the same whenever needful.

WHEN ANALYSES OF FERTILIZERS ARE MADE FOR FARMERS.

The Station does not analyze samples of fertilizers for manufacturers or dealers. It discontinued the practice some years ago, taking this action for several reasons. When the fertilizer manufacturing industry was in its infancy in North Carolina, the Station aided them in every laudable way by advice as to formulas, ingredients suitable for mixing, and by making analyses of materials for them. Now the industry has so grown that sufficient knowledge and facilities are at hand to render it unnecessary to continue the assistance formerly so freely given. Another reason why this has been withdrawn is that it was found that there was a tendency to abuse the privilege, and occasionally samples were sent to the Station and

analyzed that did not truly represent the materials sold. In this particular case, use was made of the Station's analysis in what might have been an unlawful purpose.

Analyses are still made for farmers to aid them in preventing fraud in their purchases of fertilizers; and this applies also to fertilizing ingredients, such as kainit, cotton-seed meal, chemicals, and the like. These analyses are made upon the following conditions:

1. That the article to be sampled has regularly paid the tonnage charges for inspection. This charge is extremely small in itself, and was instituted for the protection of farmers and others purchasing these materials, and enables the fertilizer inspection and control to be sustained. Millions of dollars have been saved over and over again by reason of the operations of this control and the continual careful oversight of the fertilizer trade. This protection cannot be extended to fertilizers that have not the requisite tags attached to the bags. It is unlawful for dealers to sell bags or any packages of fertilizers not properly tagged, as well as for shipping agents to deliver and consumers to remove them. Such being the case, the very fact that these materials are not tagged would indicate that they were unlawfully on the market, and farmers are advised to refuse to deal in such materials.

2. There must be some special reason for thinking the grade below the guarantee. This requirement is necessary, as otherwise the Station would receive so many samples that the analyses of the official samples might be very greatly retarded thereby if all analyses were attempted at the time they were received. The official inspectors are constantly travelling over the State during the fertilizer seasons and they draw samples wherever fertilizers are found. It is preferable that the samples should be drawn by them in the usual operations of the fertilizer control, for they have better facilities and are more thoroughly acquainted with the proper manner of taking them. On account of their official character, analyses of such samples are of far more importance in disputed cases than a sample from a private party. The Station prefers, therefore, that samples should always come through the official inspectors. Nevertheless, where there is some special reason for doubting the purity of a lot of fertilizers, it will make an analysis of a sample if all of the conditions that are named have been observed.

3. The sample must be taken according to forms prescribed by the Station, which can be obtained upon application. This is necessary in order to procure as fair and average a sample as is possible. It can be easily seen that upon the sample depends entirely the value of the analysis. If it is taken carelessly it may not represent the materials on sale, and the analysis may be entirely worthless on account of that fact. After the sample is received the Station can have no means of ascertaining by an examination of it whether it has been accurately taken or not. It must, therefore, rely for their accuracy solely on the instructions it gives in advance for drawing

these samples. In order to be positive as to the sample none should be sent coming from a manufacturer or dealer. It should always be drawn under the personal supervision of the sender. The sampling in every case must be witnessed and signed by two witnesses, stating that all the instructions have been complied with and a fair average sample has been secured, representing in their opinion the lot in question. If it is desired by the sender, the name of the brand and manufacturer, with the guaranteed percentages, may be retained until after the analysis is received by him, but in every case these must be returned to the Station for completion of the records concerning the sample. As a rule there must be at least three tons in the lot to be sampled, though in special cases exceptions are made.

The Necessity for Accurate Sampling.

Owing to the nature of the ingredients composing a fertilizer, it often happens that these ingredients do not remain thoroughly mixed. This is caused by the transportation and handling of the bag, whereby the fine and heavy particles (generally of phosphate) separate from the lighter and more bulky portions of organic materials furnishing nitrogen (or ammonia) and potash, such as cotton-seed meal and tobacco stems. The heavy particles, which are at the same time finer, have the tendency to settle towards the bottom, thereby leaving the coarse organic materials at the top. If now a sample be taken from the top of the bag only it will show by analysis a higher percentage of the nitrogen or potash than would be the case if the whole contents were carefully mixed before the sample was taken. The analysis will also show a lower percentage of phosphoric acid than should be, because a portion of the fine phosphate has already settled towards the bottom, and is not reached in the sampling. The official inspectors obviate this difficulty by the use of a long hollow steel sampling tube which is thrust in from side to side or end to end of the bag. It is then withdrawn, bringing out a core of the contents of the bag in the same position as occurring inside. The instructions for sampling, as given by the Station, suggests a plan for securing an average sample without the use of this sampling tube.

THE NEED OF FERTILIZER ANALYSIS AND EXPLANATION OF TERMS USED.

The analysis of a fertilizer is made to determine the quantity of each valuable constituent present. No one, by looking at a fertilizer, can tell its grade, and whether the constituents claimed by the manufacturers are really present. This must be done by a careful chemical examination, and this can only be accomplished by competent experts. Anterior to 1877, before the establishment of the Fertilizer Control, there being no restraint upon manufacturers, many fertilizers were of little value, and farmers were losing enormous sums

annually, with no opportunity of ascertaining the real character of the goods they were buying. The result in the field was oftentimes disastrous, and the planter lost not only the actual amount paid for the fertilizer, but also the prospective yield in his crop. Now this is changed. By the operations of the Fertilizer Control there is no opportunity for the lowest grades of fertilizers to be brought into the State, unless fraudulently. All brands proposed to be put on sale have to be first registered with the actual guaranteed percentages before they can be lawfully sold. Low grade fertilizers are excluded by law. Samples are taken of the goods after they are put on the market, analyzed and published broadcast. If the grade is found to fall materially below the guarantee it is subject to seizure and condemnation. Whenever the grade is deficient, but not materially so to cause condemnation, the analysis is printed so that the public may be warned in the future.

Terms Used in an Analysis.

All figures given in the tables, except the value per ton, are stated in per cents or parts per 100. There are three special constituents which when present give to a fertilizer its value. These are phosphoric acid, nitrogen (or ammonia) and potash. The valuable chemical elements in these constituents are phosphorus, nitrogen and potassium respectively. These constituents are never present as such, but always combined with other compounds, which combination is necessary for their existence in the fertilizer. In fact these terms so often seen, phosphoric acid, nitrogen (or ammonia) and potash, refer to chemical compounds which do not exist as such, and are only used as a convenient method of referring to the ingredients present in a fertilizer and their amounts.

Phosphoric Acid. In what combinations these three ingredients above stated occur, depend entirely upon the materials used. If the phosphoric acid is derived from the phosphates of fossil origin (South Carolina rock, etc.), as is most often the case, the phosphorus present in them is combined with lime in the form of tri-calcium phosphate, or three parts of lime in combination with phosphoric acid. As this is very insoluble in the soil and is not readily taken up by plants, it is treated with sulphuric acid to render it more soluble and available. After this treatment the phosphate contains only one part of lime and more phosphoric acid than before. It is possible for some of the soluble phosphate so made to slowly change back to the original form, but before reaching it an intermediate form may result with more lime than the soluble. This intermediate form is called the *reverted* phosphate, and the quantity present is estimated as so much *reverted phosphoric acid.* In the laboratory estimation, the soluble phosphoric acid is all that is soluble in pure cold water; the reverted phosphoric acid is that soluble in a solution of ammonium citrate according to a standard method of analysis,

but insoluble in water; and, lastly, the insoluble phosphoric acid is that which is insoluble both in water as well as in the citrate solution.

The total phosphoric acid present in a fertilizer or fertilizing ingredient is consequently made up of three forms: (1) soluble phosphoric acid, (2) reverted phosphoric acid, and (3) insoluble phosphoric acid. The last form is not considered as available to the plants as are the other two forms. The first two forms combined are often spoken of as the *available phosphoric acid*, and is not a distinct form of phosphoric acid, but is only the collective name of the reverted and soluble forms taken together. The available phosphoric acid is consequently the sum of the soluble and the reverted, or is the difference between the insoluble and the total phosphoric acid. The available phosphoric acid is now valued at 4½ cents per pound according to the plan explained further on. Equal values are there given to the soluble and reverted forms. It is likely that the Station may separate these forms in the near future and accord to the reverted a lower valuation than to the soluble phosphoric acid. The insoluble phosphoric acid is not valued, except in the case of pure bone meal, when a valuation of 3 cents per pound is given to it. This will probably be changed to embrace a range of values according to the fineness of the meal.

Nitrogen (*or Ammonia*). Nitrogen should always be used to represent compounds of this character. Ammonia is somewhat misleading, for in many cases of organic materials ammonia is not present at all, but nitrogen is present in the form of nitrogenous matters and would be a better basis of value. Ammonia, however, has become to be used so exclusively by the trade to represent these materials that the term cannot now well be dropped. Consequently both nitrogen and ammonia are given. The former is converted to ammonia by multiplying by 1.214. Only nitrogen (ammonia) from the well recognized legitimate sources is valued. Others which are considered as adulterations are not valued. The value given to the former is now 14 cents per pound.

Potash. This constituent does not exist as such but combined as sulphate, muriate (chloride), carbonate, nitrate, or inorganic combination. The potash estimated is that soluble in pure cold water and is valued at 5 cents per pound.

Water. The quantity of moisture present is estimated as a matter of interest to give an indication of the property of the fertilizer, whether dry or wet. It is not used in estimating the commercial value.

Guaranteed Percentages The percentages guaranteed by the manufacturer are given side by side with the percentages of the various constituents as found by analysis. This facilitates comparison. The commercial value as determined by these guarantees, and the same valuation of constituents as are applied in the analysis are given in the tables side by side with the commercial value as determined by the analysis.

Mechanical Condition. As a fertilizer in a fine state of subdivision is of more value than a coarse one, because it is more available to the plants in the soil, the mechanical condition of each fertilizer as it is received from the inspector is stated. In the same way a dry fertilizer is more easily handled and distributed than a damp or moist one, and is consequently of greater value. The plan for designating the mechanical condition is as follows: *r*—good, *s*—coarse, *b*—very coarse, *c*—damp, *x*—lumpy, and *z*—wet.

Relative Seaboard Value per ton of Unmixed Ingredients. For the purpose of a better comparison among the various brands, and to give some idea of their worth, the relative seaboard value of the unmixed ingredients per ton are given as determined by the analysis. In the next column is also given, calculated in a similar way, the value of the guaranteed amounts of the constituents. A fuller discussion upon these relative commercial values, how they are calculated, and in what way they are useful, will be found in the two following sections.

How the Valuations of Constituents are Determined.

The valuations of the three constituents, available phosphoric acid, ammonia, and potash, are intended to give the market price for cash at the seaboard of the ingredients making up a fertilizer. The cash prices for small lots in bags, free on board cars, are intended. These valuations are made up early in January of each year, to run through the spring and fall seasons. It is expected that there will be variations in the market price of the ingredients during the course of the year, but experience has shown that this variation will be slight. This is because fertilizing materials are largely contracted for in advance before the opening of the year, and in many cases a large majority of the fertilizers are already manipulated before the beginning of the season.

The valuation of the constituents are fixed by a careful examination of existing conditions of the trade, the markets at important centres, and from actual quotations given by seaboard manufacturers and dealers upon the various ingredients used for manipulating fertilizers. These quotations are for cash in small lots of five tons and less, free on board and bagged.

The valuations for the year 1895 have been fixed at the following rate:

For available phosphoric acid	4½	cents per	pound.
For ammonia	14	"	"
For potash	5	"	"

The analyses hereafter given in this bulletin are calculated at the above rate, which rate will be retained during the coming year, and published in the bi-weekly analyses of fertilizers already mentioned.

During the past year (1894) available phosphoric acid was valued at 5 cents per pound, ammonia at 15 cents, and potash at 5 cents. Conse-

quently the valuations for the present year (1895) are reduced by ½ cent per pound for available phosphoric acid, and 1 cent per pound for ammonia, the potash remaining the same. The reduction in phosphoric acid and ammonia is brought about by lower ruling rates of ingredients furnishing these materials. Prices now early in January are lower than during the past summer and fall, which was the time that most of the manufacturers manipulated their fertilizers for the coming year. The ingredients have steadily depreciated in value, however, and sales during the approaching season will follow these lower prices.

How Values per ton are Calculated, and How they can be Utilized by Farmers.

It may be of interest to some to know how ton values are calculated, using the valuations for the constituents just given. The amount or percentage of either of these constituents present in the fertilizers is given by the analysis. This represents parts per 100. The percentage is accordingly multiplied by the valuation per pound to get the value per 100 pounds. This is now multiplied by 20 to determine the value per ton (2,000 pounds). This is done for all three constituents, and the three amounts are added together to arrive at the cost value of the unmixed ingredients per ton at the seaboard.

The following is an example:

Percentage or pounds per 100.	*Per* 100 *lbs.*	*Per ton* (2.000 *lbs.*)
9.64 Available Phos. Acid at 4½c. per lb	**$0.4338**	**$ 8.68**
2.39 Ammonia at 14c. per lb.	**.3346**	**6.69**
3.05 Potash at 5c. per lb	**.1525**	**3.05**
Total value	**$ .9209**	**$ 18.42**

The value per ton as here given represents the market price per ton at the seaboard of the unmixed ingredients. For interior points, railroad freights to those points must be added. To facilitate further comparison, a correct table of freight rates to prominent interior points in North Carolina is inserted on page 11. This table is carefully revised to date from the published rates of the Associated Railways of Virginia and the Carolinas and can be relied upon as accurate. The values per ton represent unmixed ingredients. They how what would be the approximate cost of the ingredients to a farmer in case he bought them himself for mixing. The cost is, as stated, on the basis of cash in small lots (less than five tons) in bags, at the seaboard. By a comparison of these values as given by the Experiment Station, a farmer can see how much he is being charged over and above the actual cash cost of the unmixed raw materials. The manufacturer in addition has to allow for mixing the ingredients, branding the bags, handling, fixed charges, agents' commissions, profits, etc., together with freight to the interior point. The cost of mixing, sacking and branding the bags will not vary greatly from $2.60 per ton.

Considering all items, the cash price of a mixed ammoniated fertilizer at an interior town, ought not to be more than 25 to 33⅓ per cent. greater than the relative seaboard value per ton of unmixed ingredients as given in the tables found by analysis, with, of course, the freight from the seaboard to the interior point added.

In the tables of analyses, first column, where "F" precedes the station number, it indicates that the sample was taken during the fall inspection of 1894. All others were sampled during the spring season.

In the tables of analyses, sixth column, the letters *r*, *s*, *b*, *c*, *x*, *z*, all refer to the mechanical condition of the fertilizers, as follows: *r*—good, *s*—coarse, *b*—very coarse, *c*—damp, *x*—lumpy, and *z*—wet.

FREIGHT RATES FROM THE SEABOARD TO INTERIOR POINTS.

CORRECTED TO JANUARY 12, 1895, FROM THE PUBLISHED RATES OF THE ASSOCIATED RAILWAYS OF VIRGINIA AND THE CAROLINAS.

In Car loads, of not less than 10 tons each, per ton of 2,000 pounds. Less than Car load, add 20 per cent.

DESTINATION.	From Wilmington, N. C.	From Norfolk and Portsmouth, Va.	From Charleston, S. C.	From Richmond, Va.
Advance	$ 3 90	$ 4 10	$ 4 70	$ 3 50
Apex	2 70	3 00	4 20	3 00
Asheboro	3 60	3 80	4 40	3 20
Asheville	4 00	4 60	4 60	4 00
Chapel Hill	3 20	3 80	4 40	3 20
Charlotte	3 00	3 20	3 20	3 20
Clayton	2 70	3 60	4 20	3 00
Cherryville	3 30	3 60	3 40	3 60
Clinton	2 05	3 20	3 80	3 20
Creedmore	3 30	3 00	4 30	3 00
Cunningham	3 50	——	——	2 40
Dallas	3 40	3 50	3 40	3 50
Davidson College	3 90	4 50	4 40	3 90
Dudley	2 05	3 20	3 60	3 20
Dunn	2 40	3 00	3 95	3 00
Durham	3 00	3 00	4 20	3 00
Elkin	3 60	3 80	4 40	3 20
Elm City	2 40	2 90	3 90	2 90
Fair Bluff	2 10	3 80	2 85	3 80
Fayetteville	1 60	3 00	3 00	3 00
Forestville	3 30	3 00	4 30	3 00
Gastonia	3 40	3 50	3 40	3 50
Gibson's	2 70	4 00	2 70	4 00
Goldsboro	2 10	3 00	3 65	3 00
Greensboro	3 00	3 00	3 80	3 00
Hamlet	2 70	3 20	4 00	3 20
Henderson	3 30	3 00	4 30	3 00
Hickory	4 00	4 00	4 60	4 00
High Point	3 40	3 80	4 20	3 20
Hillsboro	3 00	3 60	4 20	3 00
Kernersville	3 40	3 60	4 20	3 00
Kinston	2 20	2 50	3 75	2 50
Laurel Hill	2 60	3 80	4 00	3 80
Laurinburg	2 30	3 80	4 00	3 80
Liberty	2 50	3 60	3 80	3 60
Louisburg	3 30	3 00	4 30	3 00
Lumberton	2 20	3 80	3 70	3 80
Macon	3 30	3 00	4 30	3 00
Madison	3 00	3 00	4 20	3 00
Matthews	3 00	3 20	3 20	3 20
Maxton	$ 2 20	$3 80	$3 50	$ 3 80
Mebane	3 00	3 60	4 20	3 00
Milton	3 75	2 40	4 50	2 30
Mocksville	3 90	4 10	4 70	3 50
Monroe	3 00	3 20	3 20	3 20
Morven	2 70	3 85	2 70	3 85
Mount Airy	3 20	3 50	4 20	3 50
Nashville	2 40	3 00	3 95	3 00
Newbern	1 75	3 30	3 95	3 30
Norwood	3 50	3 80	4 20	3 20
Oxford	3 50	3 60	4 50	3 00
Pineville	3 20	3 95	3 20	3 45
Pittsboro	2 70	3 30	4 40	3 30
Polkton	2 75	3 20	3 20	3 20
Raleigh	2 70	3 00	4 20	3 00
Reidsville	3 75	3 00	4 50	2 40
Rockingham	2 70	3 20	4 00	3 20
Rocky Mount	2 40	2 90	3 95	2 90
Ruffin	3 75	2 80	4 50	2 20
Rural Hall	3 20	3 20	4 40	3 20
Rutherfordton	3 40	3 65	3 40	3 65
Salisbury	3 50	3 80	4 20	3 20
Sanford	2 20	3 00	3 80	3 00
Selma	2 40	3 00	3 95	3 00
Shelby	3 40	3 60	3 40	3 60
Siler City	2 40	3 60	3 80	3 60
Smithfield	2 40	3 00	3 95	3 00
Spring Hope	2 45	3 00	4 00	3 00
Statesville	3 20	3 80	4 40	3 20
Stem	3 50	3 60	4 50	3 00
Tarboro	2 00	2 00	3 55	2 50
Waco	3 30	3 60	3 40	3 60
Wadesboro	2 70	3 20	2 70	3 00
Walnut Cove	3 00	3 00	4 20	3 20
Warrenton	2 55	2 25	4 55	3 00
Warsaw	2 00	3 20	3 55	3 20
Washington	1 75	1 75	3 25	1 75
Weldon	2 45	2 00	4 00	2 00
Wilson	2 40	2 90	3 90	2 90
Winston-Salem	3 00	3 00	4 20	3 00

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8433	Acme Acid Phosphate	Acme Mf'g Co., Wilmington, N. C.	1
8426	Acme Fertilizer	Acme Mf'g Co., Wilmington, N. C.	2
8410	Allen's Eight Per Cent. Guano	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	3
8411	Allen's Potato Manure	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	4
8501 F 8783	Allison & Addison Acid Phosphate.	Allison & Addison, Richmond, Va.	5
8368 F 8774	Americus Brand Ammoniated Superphosphate.	Williams & Clark Fertilizer Co., New York, N. Y.	6
8477	Ammoniated Soluble Navassa Guano.	Navassa Guano Co., Wilmington, N.C	7
8487 8603	Ammoniated Soluble Navassa Guano for Tobacco.	Navassa Guano Co., Wilmington, N.C	8
8451	Anchor Brand Fertilizer	Allison & Addison, Richmond, Va.	9
8448	Anchor Brand Tobacco Fertilizer.	Allison & Addison, Richmond, Va.	10
8462	Ashepoo Acid Phosphate	Ashepoo Phosph'te Co., Charleston, S.C	11
8470	Ashepoo Fertilizer	Ashepoo Phosph'te Co., Charleston, S.C	12
8517	Ashley Soluble Guano	Ashley Phosphate Co., Charleston, S.C	13
8466	Atlantic Acid Phosphate	Atlantic Phosphate Co., Charleston, S. C.	14
8611 F 8801	Banner Fertilizer	Reidsville Fertilizer Co., Reidsville, N. C.	15
8397	Baker's Standard Guano	Chemical Co. of Canton, Baltimore, Md	16
8378	Baugh's Animal Bone and Potash Compound.	Baugh & Son's Co,, Norfolk, Va	17
8633 F 8799	Baugh's Bone Meal	Baugh & Son's Co., Norfolk, Va	18
8532	Baugh's Dissolved Animal Bone	Baugh & Son's Co., Norfolk, Va	19
8372 8629	Baugh's High Grade Dissolved S. C. Rock.	Baugh & Son's Co., Norfolk, Va	20
8439	Baugh's High Grade Dissolved S. C. Rock, 13 per cent.	Baugh & Son's Co., Norfolk, Va	21
8530	Baugh's High Grade Tobacco Manure.	Baugh & Son's Co., Norfolk, Va	22
8404	Baugh's Seven Per Cent. Potato Guano.	Baugh & Son's Co., Norfolk, Va	23
8375	Baugh's Special Cotton Guano	Baugh & Son's Co., Norfolk, Va	24
8379	Baugh's Special Substitute for Peruvian Guano.	Baugh & Son's Co., Norfolk, Va	25
8473 F 8795	Beef, Blood, and Bone Fertilizer	S. W. Travers & Co., Richmond, Va.	26
8580	Berkeley Acid Phosphate	Berkeley Phosphate Co., Charleston, S. C.	27
8554	Berkeley Ammoniated Fertilizer.	Berkeley Phosphate Co., Charleston, S. C.	28
8552	Berkeley Dissolved Bone	Berkeley Phosphate Co., Charleston, S. C.	29

NOTE. 8633—The total phosphoric acid in pure bone meal is valued at 3 cents per pound.
F 8799—The total phosphoric acid in pure bone meal is valued at 3 cents per pound.

	Place where Sampled, and Mechanical Condition of Fertilizer. (See page 11)	Water.	Insoluble Phos Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid. Found.	Available Phos. Acid. Guaranteed.	Nitrogen.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Found.
													$	$
1	Maxton r ----	15.33	1.00	11.30	2.37	13.67	12	---	---	---	--	----	10.80	12.30
2	Rockingham r	11.12	0.82	6.05	2.09	8.14	8	2.56	3.11	3	2.67	2½	18.10	18.70
3	Washington s	9.03	0.72	4.46	3.65	8.11	7	6.66	8.09	8	4.43	4	32.70	34.38
4	Washington s	10.47	1.34	4.07	2.70	6.77	6	3.28	3.98	4	8 54	9	25.60	25.78
5	Siler City r---	15.20	1.19	9.74	2.67	12.41	12	---	---	----	---	----	10.80	11.17
	Thomasville r	13.96	1.06	9.91	3 47	13.38		---	---	----	---	----		12.04
6	Wilmington r	14.27	4.06	6.67	2.42	9.09	8	1.98	2.40	2½	1.31	1	14.50	16.21
	Woodside r --	11.50	4.31	1.80	7.07	8.87		1.87	2.27		1.30			15.64
7	Smithfield r--	12.00	1.91	6.95	2.63	9.58	8	2.24	2.72	2½	2.09	2	16.20	18.33
8	Battleboro r--	10.37	2.14	6.64	2.95	9.59	8	2.24	2.72	2½	1 84	2	16.20	18.09
	Mt. Airy r c--	14.00	1.51	6 54	2.98	9.52		2.06	2.50		2 40			17.97
9	Kinston r----	13 89	1.36	7.01	2.63	9.64	8	1.71	2.08	2	1 39	1½	14.30	15.89
10	Kinston r----	13.18	1 96	6.64	2.76	9.40	8	2.27	2.76	3	1.92	1½	17.10	18.11
11	Charlotte r---	13.59	1.91	10.07	3 01	13.08	10	----	---	----	---	---	9.00	11.77
12	Pineville z ---	16.94	2.16	5.37	4.30	9 67	8	1.78	2.16	2	1.75	1	13.80	16.50
13	Morven r ----	17.25	2.21	6.50	2.28	8.78	8	2.33	2.83	2½	1 39	1	15.20	17.22
14	Pineville r ---	15.95	0.92	10.21	2.44	12.65	10	----	---	----	1.42	1	10.00	12.81
15	Mebane r ----	13.69	1.01	5.82	3.38	9.20	8	1.61	1 95	2	1.71	1	13.80	15.45
	Greensboro s-	9.85	1.15	4.54	3.11	7.65		1.51	1 83		1 62			13.63
16	Williamston s	12.85	2.06	6.87	1.68	8.55	8	1.94	2 36	2	1 89	2	14.80	16.19
17	Newbern r---	13 45	3.68	5.97	2.49	8.46	8	1.89	2.29	2	1 96	2	14.80	15.99
18	Greensboro r-	7.53	---	See	foot	note.	----	3.20	3.88	4	---	----	24.10	23 72
	Greensboro s-	5.34	---				----	3.79	4.60		---	----		25.70
19	Winston r ---	6.53	4.36	1.59	11.56	13.15	10	3.22	3.91	3	---	--	17.40	22 78
20	Newbern z ---	24.43	1.15	7.31	3.42	10 73	12	----	---	---	---	----	10.80	9 66
	Newbern r---	21.00	1.09	8.24	3.73	11.97		----	---	----	---	---		10.77
21	Kinston r----	13.50	0.64	10.89	2 84	13.73	13	---	---	---	---	----	11.70	12.36
22	Hillsboro r---	11.58	3.07	5.50	3.95	9.45	8	2.88	3.50	3	3.23	3	18.60	21.54
23	Washington s	7.53	1.37	5.48	1.85	7.33	6	5.58	6.77	7	4 99	5	30.00	30.54
24	Newbern r---	16.77	3.93	6.41	2.26	8.67	8	1.94	2.36	2	---	----	12 80	14.41
25	Newbern s---	10.40	2.42	4.80	3.68	8.48	8	4.64	5.63	5	5.00	5	26.20	28.40
26	Lumberton r-	12.45	1.30	6 68	2.43	9.11	8	1.71	2.08	2	1.37	1	13.80	15.39
	Statesville r--	11.05	1.84	5.16	2.85	8.01		1.63	1 98		1.01			13 76
27	Morven r ----	15.78	1.20	6.90	3.35	10.25	10	----	---	----	1.86	1½	10.50	11.69
28	Waxhaw r---	17.77	0.95	6.55	2.63	9.18	8	1.88	2.28	2	1.01	1	13.80	15.66
29	Waxhaw r---	15.60	1.15	10.58	3.58	14.16	12	----	---	----	---	----	10.80	12.74

21.50 per cent. is guaranteed, 21.43 is found.
21.50 per cent. is guaranteed, 21.38 is found.

Station Number.	NAME OF BRAND.	NAME OF MANUFACTURER OR AGENT.	
8581	Berkeley Soluble Guano	Berkeley Phosphate Co., Charleston, S. C.	30
8609	Bone Meal, pure ground	Eli D. C. Wilson, McLeansville, N. C.	31
8560	Bone Plant Food	N. C. Cotton Oil Co., Raleigh, N. C.	32
8456	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., Boston, Mass.	33
8610	Broad Leaf Tobacco Guano	Reidsville Fertilizer Co., Reidsville, N. C.	34
8492, F 8790	Capital Dissolved S. C. Bone	S. W. Travers & Co., Richmond, Va.	35
8519	Capital Tobacco Fertilizer	S. W. Travers & Co., Richmond, Va.	36
8478	Carolina Acid Phosphate	F. S. Royster, Tarboro, N. C.	37
8442	Carolina Soluble Bone and Potash.	F. S. Royster, Tarboro, N. C.	38
8553	Cerealite Top Dressing	Boykin, Carmer & Co., Baltimore, Md	39
8570, F 8781	Champion Acid Phosphate	S. W. Travers & Co., Richmond, Va.	40
8488	Charleston Acid Phosphate	W. J. Crumpler, Washington, N. C.	41
8432, F 8763	Charlotte Acid Phosphate	Charlotte Oil and Fertilizer Co., Charlotte, N. C.	42
8430, F 8776	Charlotte Ammoniated Fertilizer.	Charlotte Oil and Fertilizer Co., Charlotte, N. C.	43
8506	Chesapeake Guano	Chesapeake Guano Co., Baltimore, Md	44
8498	Chesapeake Guano prepared for Latta & Myatt.	Chesapeake Guano Co., Baltimore, Md	45
8592	Chesapeake Guano prepared for Latta & Myatt.	Chesapeake Guano Co., Baltimore, Md	46
8461	Chicora Dissolved Bone	Chicora Fertilizer Co., Charleston, S. C.	47
8500	Chicora Dissolved Bone	Chicora Fertilizer Co., Charleston, S. C.	48
8533, F 8772	Climax Dissolved Bone	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	49
8614	Conetoe Special Guano for all crops.	Imperial Guano Co., Norfolk, Va.	50
8472	Cotton Brand Acid Phosphate.	Powers, Gibbs & Co., Wilmington, N. C.	51
8480	Cotton Brand Ammoniated Dissolved Bone.	Powers, Gibbs & Co., Wilmington, N. C.	52
8423	Cotton Brand High Grade Acid Phosphate.	Powers, Gibbs & Co., Wilmington, N. C.	53
8613, F 8798	Crenshaw's Acid Phosphate or Dissolved S. C. Bone.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	54
8523	Crown Brand Ammoniated Fertilizer.	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	55
8416	Crumpler's Standard Premium Guano.	Imperial Guano Co., Norfolk, Va.	56
8483	Darlington Acid Phosphate	Darlington Phosphate Co., Darlington, S. C.	57
8534	Davie & Whittle Acid Phosphate.	Davie & Whittle, Petersburg, Va.	58

NOTE. 8609.—The total phosphoric acid in pure bone meal is valued at 3 cents per pound

Place where Sampled, and Mechanical Condition of Fertilizer. (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash		Relative Seaboard Value per ton of Unmixed Ingredients.	
					Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
												$	$
30 Morven *r*. ...	15.33	0.95	6.01	2.38	8.39	8	2.07	2.51	2¼	1.51	1	15 20	16.09
31 Greensboro *s*.	7.89	See foot	note		----	----	3.73	4.53	3½	---	---	20.79	24.81
32 Louisburg *r*..	9.95	1 34	6.82	2.80	9 62	8	2.22	2.70	2½	1.97	1½	15.70	18.19
33 Wilson *r*.....	16.03	1.28	7.01	3.42	10.43	9	1.87	2 27	2¼	1,43	1	15.40	17.17
34 Mebane *r*......	13.13	2.53	5.18	3.68	8.86	8	2.00	2.43	2	3.20	2	14.80	17.98
35 Carthage *r*...	14.59	1.41	8.29	3.71	12.00	10	---	---	----	---	----	9.00	10,80
Statesville *r*..	12.63	1.54	9.20	3.17	12.37		----	---	----	---	--		11.13
36 Enfield *r*......	11.93	0.74	7.98	1.69	9.67	8	2.83	**3.44**	4	3.05	3	21.40	**21.39**
37 Elm City *r*...	12.53	2.29	10.50	3.19	13.69	10	--	---	----	---	..	9.00	12.32
38 Kinston *r*	11.16	0.87	6.59	2.12	8.71	8	---	---	----	2.17	2	9.20	10.01
39 Laurinburg *r*.	7.66	---	----	----	----	----	7.38	**8.96**	9	2.88	2½	27.70	27.97
40 Greenville *r*..	14.98	0.81	8.24	4.01	12 25	10	----	---	--	---	----	9.00	11.03
Thomasville *r*	14.25	0.90	9.21	3.11	12.32		----	---	----	---	----		11.09
41 Washington *r*	14.03	2.16	9.59	3.92	13.51	13	---	---	---	---	----	11.70	12.16
42 Maxton *r*. ...	17.16	0.33	11.33	2.30	13.63	13	----	---	----	---	---	11.70	12.27
Cherryville *r*.	12.65	1.02	11.60	3.46	15.06			---	---	---	----		13.55
43 Gibson *r*	12.04	0.28	8.00	1.51	9.51	8	2.53	3.07	2½	1.81	1½	15.70	18.97
Concord *r*....	11.68	0.24	7.56	2.15	9.71		2.24	2.72		1.79			18.15
44 Raleigh *r*	12 15	1.13	6 58	2.49	9.07	8	1.88	2.28	2	1.45	1	13.80	16.00
45 Raleigh *r*	14.05	1.55	7.94	2 11	10.05	10	2.04	**2.48**	2.60	1.80	1.18	17.46	17.79
46 Raleigh *r*	10.54	1.79	7.88	2.30	10.18	10	2.17	**2.63**	2¾	1.45	1¼	17.95	17.98
47 Monroe *r*......	13.21	1.59	11.91	2.18	14.09	12	----	---	----	---	----	10.80	12.68
48 Greensboro *r*.	14.11	1.94	11.76	2.73	14.49	13	----	---	----	---	----	11.70	13.04
49 Burlington *r*	12.76	1 57	11.00	3.15	14.15	13	---	---	---	---	----	11.70	12.74
Salisbury *r*...	13.69	1.57	9.99	3.55	13.54		----	---	----	---	----		12.19
50 Conetoe *r* ...	15.08	1.33	6.69	3.49	10.18	8	1.95	2.37	2	1.89	1½	14.30	17.69
51 Lumberton *r* .	14.15	2.07	11.40	2.42	13.82	12	----	---	----	---	----	10.80	12.44
52 Elm City *r* ...	10.92	1.97	7.11	2 60	9 71	8	1.89	2.29	2	2.03	1	13.80	17.18
53 Gibson *r*	12.85	3.01	9.36	3.38	**12.74**	13	---	---	----	---	----	11.70	**11.47**
54 Williamston *r*	11.75	1.04	12.49	2.91	15.40	13	--	---	---	---	..	11.70	13.86
Greensboro *r*.	9.36	0.81	12.81	2.40	15.21		--	---	---	---	----		13.69
55 Wilson *r*......	11.47	0.96	7.36	2.87	10.23	9	1.83	2 22	2	1.40	1	14.70	16.82
56 Washington *s*	15.72	1.30	6.46	2.74	9.20	8	2.25	2.73	2	1.98	1½	14.30	17.90
57 Wadesboro *r*.	11.69	2.38	6.79	5.07	11.86	10	----	---	----	1.45	1	10.00	12.12
58 Graham *r*....	13.47	0.77	9.19	4.24	13.43	12	----	---	----	---	---	10.80	12.09

18.32 per cent. is guaranteed, 20.21 is found.

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8391	Detrick Acid Phosphate	Detrick Fertilizer and Chemical Co., Baltimore, Md.	59
8631 F 8770	Diamond Soluble Bone	Walton & Whann Co., Wilmington, Delaware.	60
F 8786	Dissolved Bone and Potash for Corn and Wheat.	American Fertilizing Co., Norfolk, Va	61
8550	Dixie Guano	Rasin Fertilizer Co., Baltimore, Md.	62
8497 8595 8777	Durham Bull Ammoniated Fertilizer.	Durham Fertilizer Co., Durham, N.C.	63
8437	Durham Bull Ammoniated Fertilizer with Peruvian Guano	Durham Fertilizer Co., Durham, N.C.	64
8421 F 8765	Durham Bull High Grade Acid Phosphate.	Durham Fertilizer Co., Durham, N. C.	65
8499	Eclipse Acid Phosphate	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	66
8507 8650	Eclipse Ammoniated Guano	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	67
8503 F 8792	Edisto Acid Phosphate	Edisto Phosphate Co., Charleston, S. C.	68
8464 F 8791	Edisto Dissolved Bone	Edisto Phosphate Co., Charleston, S. C.	69
8510 F 8796	Edisto Soluble Guano	Edisto Phosphate Co., Charleston, S. C.	70
8525 F 8794	Empire Guano	Rasin Fertilizer Co., Baltimore, Md.	71
8571 F 8784	Eureka Acid Phosphate or Dissolved S. C. Bone.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	72
8469 F 8787	Eureka Ammoniated Bone Superphosphate.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	73
8572	Eureka Ammoniated Bone Superphosphate for Tobacco.	Atlantic and Virginia Fertilizing Co., Richmond, Va	74
8588	Eureka Bone and Potash Compound.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	75
8524	Excellenza Soluble Guano	Jno. S. Reese & Co., Baltimore, Md.	76
F 8769	Excelsior Acid Phosphate	Walton & Whann Co., Wilmington, Delaware.	77
8394 8450	Farmer's Bone Fertilizer	F. S. Royster, Tarboro, N. C.	78
8505 F 8756	Farmer's Friend Fertilizer	Old Dominion Guano Co., Norfolk, Virginia.	79
8627	Farmer's Friend H. G. Special Tobacco Fertilizer.	Old Dominion Guano Co., Norfolk, Virginia.	80
8626	Farmer's Standard Ammoniated Bone for Tobacco.	Mt. Airy Manufacturing Co., Baltimore, Md.	81
8489	Fish Scrap	Dey & Bro., Beaufort, N. C	82
8543	Freeman's 7 per cent. Irish Potato Grower.	E. B. Freeman & Co., Norfolk, Va.	83
8546	Game Guano	Baltimore Guano Co., Baltimore, Md	84
8475	Gem Fertilizer	Acme Manufacturing Co., Wilmington, N. C.	85
8438	Gibbs & Co.'s High Grade Ammoniated Phosphate.	Powers, Gibbs & Co., Wilmington, N. C.	86

Place where Sampled, and Mechanical Condition of Fertilizer. (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid. Found.	Available Phos. Acid. Guaranteed.	Nitrogen.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Found.
												$	$
59 Edenton r	13.96	1.32	11.17	2.31	13.48	14	....	...	....	--	....	12.60	12.13
60 Salisbury r	13.22	1.69	11.60	2.60	14.20	13	....	...	....	...	....	11.70	12.78
Waco r	11.12	0.65	11.90	2.94	14.84		....	...	....	...	....		13.36
61 Lexington s	15.57	0.10	8.74	2.09	10.83	10	...	...	...	2.61	2	11.00	12.36
62 Tarboro r	16.06	0.86	6.37	1.93	8.30	8	1.80	2.19	2	1.30	1	13.80	14.90
63 Norwood s	11.17	3.98	5.51	2.96	8.47	8	1.41	1.71	2	1.70	1½	14.30	14.11
Fremont r	11.96	3.16	5.50	3.05	8.55		1.50	1.82		1.83			14.62
Concord s	8.82	3.80	5.65	3.11	8.76		1.64	1.99		1.92			15.38
64 Laurinburg s	11.65	2.47	6.15	2.93	9.08	8	2.08	2.53	2½	2.47	2	16.20	17.73
65 Rockingham r	15.38	1.85	8.98	2.87	11.85	10	....	...	....	...	....	9.00	10.67
Cherryville r	13.48	1.07	11.69	2.37	14.06		....	...	....	...	....		12.65
66 Raleigh r	14.42	1.77	11.94	1.96	13.90	13	....	...	....	...	....	11.70	12.51
67 Louisburg r	11.36	0.86	6.79	2.87	9.66	8	1.86	2.26	2½	1.52	1½	15.70	16.54
Wadesboro r	11.59	1.28	6.23	2.34	8.57		2.48	3.01		1.86			18.00
68 Concord r	15.08	0.47	9.51	3.98	13.49	10½	...	...	....	1.44	1½	10.95	13.58
Hickory r	13.23	1.20	9.56	2.57	12.13		....	...	....	1.52	....		12.44
69 Pineville r	16.24	1.54	10.30	3.22	13.52	12	....	...	....	...	....	10.80	12.17
Hickory r	14.45	1.92	11.49	2.44	13.93		...	...	....	...	....		12.54
70 Concord r	11.36	3.90	3.84	6.43	10.27	8	1.93	2.34	2	1.34	1	13.80	17.14
Hickory r	16.48	2.65	7.24	2.71	9.95		1.44	1.75		1.59			15.45
71 Nashville r	15.27	1.69	6.90	2.09	8.99	8	2.05	2.49	2.43	1.73	1½	15.50	16.79
Conover r	13.94	2.78	5.63	2.94	8.57		1.94	2.36		2.00			16.32
72 Elkin r	13.51	1.65	8.61	3.65	12.26	10	....	...	....	...	....	9.00	11.03
Thomasville r	12.98	2.03	11.23	0.39	11.62		....	...	....	...	....		10.46
73 Pineville s	10.74	3.31	5.62	3.82	9.44	8	1.73	2.10	2	2.36	2	14.80	16.74
Lexington s	10.72	3.13	6.18	3.53	9.71		1.18	1.43		1.40			14.14
74 Elkin s	14.23	1.11	6.68	2.34	9.02	9	1.81	2.20	2½	2.75	2	17.10	17.03
75 Winston s	11.40	2.02	2.52	9.28	11.80	10	....	...	....	2.18	2	11.00	12.80
76 Spring Hope r	14.82	1.39	3.19	7.23	10.42	8½	1.95	2.37	2½	1.64	$1\frac{2}{10}$	15.15	17.65
77 Waco r	8.00	3.99	4.53	6.51	11.04	10	....	...	....	...	....	9.00	9.94
78 Williamston s	19.26	0.54	6.72	1.63	8.35	8	1.90	2.31	2	2.04	2	14.80	16.02
Kinston r	18.45	0.33	6.64	2.00	8.64		1.93	2.34		2.15			16.48
79 Raleigh s	13.50	0.38	6.92	3.00	9.92	8	1.81	2.20	2	2.31	2	14.80	17.40
Shelby r	13.19	0.96	6.52	2.40	8.92		1.74	2.11		2.24			16.18
80 Leaksville r	14.18	1.16	6.88	1.87	8.75	8	2.45	2.97	3	3.51	3	18.60	19.70
81 Reidsville r	9.43	2.33	5.54	3.45	8.99	8	1.80	2.19	2	1.44	1½	14.05	15.66
82 Newbern s	8.89	...	....	....	....	....	8.22	9.98	9	...	....	25.20	27.94
83 Greenville r	11.58	0.78	6.28	1.42	7.70	7	5.04	6.12	7	3.13	3	28.90	27.20
84 Greenville r	11.55	1.85	6.74	1.90	8.64	8	1.96	2.38	2	1.82	2	14.80	16.26
85 Fayetteville r	13.34	0.86	7.01	1.89	8.90	8	1.71	2.08	2	2.09	2	14.80	15.92
86 Laurinburg s	9.83	1.68	6.81	2.44	9.25	8	2.45	2.97	2½	2.45	1	15.20	19.09

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8535	Griffith's Double Bone Phosphate.	Durham Fertilizer Co., Durham, N C	87
8407	High Grade Premium Guano	Geo. L. Arps & Co , Norfolk, Va	88
8658	Hill's Bright Tobacco Guano	John R Hill, South Boston, Va	89
8557	Home Fertilizer Chemicals	Boykin, Carmer & Co., Baltimore, Md	90
8395	Honest Dollar Pure Bone Phosphate.	Wooldridge Fertilizer Co., Baltimore, Maryland.	91
F 8762	Imperial Acid Phosphate	Imperial Fertilizer Co., Charleston, S. C.	92
F 8778	Imperial Ammon'ted Fertilizer	Imperial Fertilizer Co., Charleston, S. C.	93
8414	Imperial Cotton Grower	Imperial Guano Co., Norfolk, Va	94
F 8773	Imperial Dissolved Bone and Potash.	Imperial Fertilizer Co , Charleston, S. C.	95
8545	Imperial Guano for Tobacco	Imperial Guano Co., Norfolk, Va	96
F 8779	Imperial Soluble Guano	Imperial Fertilizer Co., Charleston, S. C.	97
8616	Iseley's Formula of Dissolved Bone, Potash and Chemicals	Old Dominion Guano Co., Norfolk, Va	98
8373	Kainit, Genuine German	Baugh & Sons Co., Norfolk, Va	99
8365	Kainit, Genuine German	Durham Fertilizer Co., Durham, N. C	100
8364	Kainit, Genuine German	Powers, Gibbs & Co., Wilmington, N. C	101
8460	Kainit, Genuine German	Stono Phosphate Works, Charleston, S. C.	102
8491	Kainit, Genuine German	Old Dominion Guano Co , Norfolk, Va	103
8424	Kainit, Genuine German	Calder Bros., Wilmington, N. C	104
8551	Kainit, Genuine German	Wando Phosphate Co., Charleston, S. C	105
8586	Kainit, Genuine German	Navassa Guano Co., Wilmington, N. C	106
8459	Kainit, Genuine Leopoldshall	Edisto Phosphate Co., Charleston, S. C	107
8374	Kainit, Old Reliable Brand German.	L. Harvey, Kinston, N C	108
8453	Kainit, Pure German	R. N. Sweet, Wilmington, N. C	109
8392	Kangaroo Komplete Kompo'nd	Wooldridge Fertilizer Co., Baltimore, Md.	110
8427	Latimer's Cotton Fertilizer	Acme Manufacturing Co , Wilmington, N. C.	111
8399	Lazaretto Acid Phosphate	Lazaretto Guano Co., Baltimore, Md	112
8417	Lazaretto Crop Grower	Lazaretto Guano Co., Baltimore, Md	113
8418	Lazaretto Early Trucker	Lazaretto Guano Co , Baltimore, Md	114
8558	Lazaretto Special Tobacco Fertilizer.	Lazaretto Guano Co., Baltimore, Md	115
8561	Lee Brand Fertilizer	Jas. G. Tinsley & Co., Richmond, Va.	116
8589	Lee Brand Guano	Jas. G. Tinsley & Co , Richmond, Va	117
8531	Liebig Standard Fertilizer	Liebig Manufacturing Co., New York, N. Y.	118
8370	Lister's Ammoniated Dissolved Bone Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	119
8444	Mapes' Manure for Potatoes	Mapes' Formula and Peruvian Guano Co., New York, N. Y.	120
8452	Meadows' Cotton Guano	E. H. & J. A. Meadows Co., Newbern, N. C.	121
8440	Meadows' Diamond Dissolved Bone.	E. H. & J. A. Meadows Co., Newbern, N. C.	122

Place where Sampled, and Mechanical Condition of Fertilizer. (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid. Found.	Available Phos. Acid. Guaranteed.	Nitrogen.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Found.
												$	$
87 Winston r....	15.04	0.96	12.54	1.61	14.15	12	....	...	....	...	...	10.80	12.74
88 Washington r	14.46	1 59	7.28	1.56	8.84	8	2.09	2.54	2	1.79	1½	14.30	16.86
89 Pelham r.....	13.91	0.72	7.62	1.89	9.51	8½	1.95	2 37	2¼	2.60	2¼	16.20	17.80
90 Greenville r.	6.02	...	...	....	....	....	5.22	6 34	7	8.57	7	26.60	26.32
91 Eliz'b'th City s	10.08	3.03	6.12	4.03	10.15	8	2.94	3.57	3½	6.81	7	24.00	25.94
92 Bushy Creek r	11.21	2.23	4.27	7.60	11.87	10	....	--	....	2.24	1	10.00	12.92
93 Bushy Creek r	12.98	3.25	7 97	1.42	9.39	8	2.09	2.54	2½	1.48	1	15.20	17.04
94 Washington r	15.21	1.39	6.79	2 55	9.34	8	2.08	2.53	2	1.59	1½	14.30	17.08
95 Concord r....	9.35	2.64	7.71	4.36	12.07	10	....	...	--	1.24	1	10.00	12.10
96 Washington s	10.17	1.70	4.61	3.86	8.47	8	3.08	3 74	3	3.36	3	18.60	21.46
97 Bushy Creek r	12.73	3.17	7.89	1.54	9.43	8	2.05	2.49	2	1.61	1	13.80	17.07
98 Burlington s..	13.56	2.03	6.04	2.78	8.82	8	2.39	2.90	3	3.51	3	18.60	19.57
99 Newbern s ...	6.32	...	...	....	....	...	...	...	...	12.00	12	12.00	12.00
100 Wilmington s	3.53	...	....	....	....	....	....	...	....	12.39	12	12.00	12.39
101 Wilmington s	4.10	...	....	....	--	....	...	...	....	12 38	12.43	12.43	12 38
102 Pineville r ...	6.22	--	...	....	....	....	....	--	....	12.42	11	11.00	12.42
103 Dunn r.......	4.46	...	....	....	....	....	...	...	....	12.46	12.43	12.43	12.46
104 Gibsons r.....	6.57	...	....	....	....	...	....	--	....	11 97	12.43	12.43	11.97
105 Waxhaw r...	4.15	...	....	....	...	...	...	...	....	11.88	10	10.00	11.88
106 Mt. Olive r ...	5.22	...	....	...	....	....	...	...	...	12.34	11½	11.50	12.34
107 Pineville r..	6.27	...	....	....	....	...	....	...	....	12.33	12	12.00	12.33
108 Newbern s ...	3.70	..	...	....	....	....	....	...	....	12.26	12.43	12.43	12.26
109 Goldsboro r .	7.56	...	....	--	..	..	...	...	...	11 93	12.43	12.43	11 93
110 Eliz'b'th City r	11.19	4.27	3.56	5.55	9.11	8	1.78	2.16	2	2.44	2	14.80	16.69
111 Rockingham r	11.77	2 51	6 03	2.21	8.24	8	2.06	2.50	2½	3.02	2	16.20	16.44
112 Washington r	14.93	0.27	12.54	2.78	15.32	13	--	...	...	....	....	11.70	13.79
113 Washington r	12.56	1.14	7.66	1.73	9.39	9	1.95	2.37	2	1.77	1	14.70	16.86
114 Washington r	12.31	1.57	6.04	1.56	7.60	7	3.73	4 53	5	4.21	4	24.30	23 73
115 Greenville r..	12.67	0.78	7.89	1.81	9.70	9	2.38	2.89	3	2.72	3	19.50	19.54
116 Louisburg r	11.27	1.00	6.19	2.42	8.61	8	1.66	2 02	2	2.37	2	14.80	15.78
117 Fair Bluff r ..	14.09	0.72	6.72	2.40	9.12	8	1.59	1 93	2	2.24	2	14.80	15 85
118 Winston r....	17.48	0.64	0.77	9.34	10.11	8	1.56	1 89	2	2.29	2	14.80	16.68
119 Wilmington r	17.07	2.14	6.65	1.94	8.59	8	1.99	2 42	2½	2.35	2	16.20	16.86
120 Newbern s ...	7.00	1.89	4.81	2.90	7.60	8	3.64	4.42	4½	8.36	6	25.80	27.58
121 Kinston r	14.34	0.50	7.91	2.04	9.95	8	1.90	2.31	2¼	2.64	2	15.50	18.06
122 Kinston c	17.21	0.54	11.03	2.86	13 89	14	...	...	--	....	....	12.60	12 50

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8447	Meadows' Great Cabbage Guano	E. H. & J. A. Meadows Co., Newbern, N. C.	123
8403	Meadows' Great Potato Guano	E. H. & J. A. Meadows Co., Newbern, N. C.	124
8446	Meadows' Labos Guano	E H. & J. A. Meadows Co., Newbern, N. C.	125
8521	Mt. Airy Guano for Potatoes	Mt Airy Manufacturing Co., Baltimore, Md.	126
8474	National Fertilizer	S W. Travers & Co., Richmond, Va.	127
8496	National Special Tobacco Fertilizer.	S. W. Travers & Co., Richmond, Va.	128
8422	Navassa Acid Phosphate	Navassa Guano Co., Wilmington, N.C	129
8425	Navassa Ammoniated Cotton Fertilizer.	Navassa Guano Co., Wilmington, N. C	130
8574 F 8775	Navassa Grain Fertilizer	Navassa Guano Co., Wilmington, N.C	131
8767	Norfolk Soluble Bone	Old Dominion Guano Co., Norfolk, Va	132
8376	N. C. Cabbage Grower	Baugh & Sons Co., Norfolk, Va	133
8377	N. C. Fish Mixture	Baugh & Sons Co., Norfolk, Va	134
8587	N. C. Official Farmer's Alliance Acid Phosphate	Durham Fertilizer Co., Durham, N. C	135
8436 8582 8597 F 8800	N. C. Official Farmers' Alliance Guano.	Durham Fertilizer Co., Durham, N. C	136
8544	Ober's Special Compound for Tobacco	G. Ober & Sons Co., Baltimore, Md.	137
8509	Ober's Special Cotton Compound.	G. Ober & Sons Co., Baltimore, Md.	138
8659	Ober's Standard Tobacco Fertilizer.	G. Ober & Sons Co., Baltimore, Md.	139
8502 F 8761	Old Dominion Dissolved Bone and Potash.	Old Dominion Guano Co., Norfolk, Va	140
F 8766	Old Dominion H G. Bone Phosphate for Wheat.	Old Dominion Guano Co., Norfolk, Va	141
8528 8366 F 8757	Old Dominion Soluble Guano	Old Dominion Guano Co., Norfolk, Va	142
8591	Old Dominion Soluble Tobacco Guano.	Old Dominion Guano Co., Norfolk, Va	143
8471 F 8793	Orient Complete Manure	Atlantic and Virginia Fertilizing Co., Richmond, Va.	144
8526 8596	Orinoco Tobacco Guano	F. S. Royster, Tarboro, N. C.	145
8612	Our Acid Phosphate or Dissolved S. C. Bone.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	146
8435	Owl Brand Guano	Davie & Whittle, Petersburg, Va	147
8559	Owl Brand Special Tobacco Guano.	Davie & Whittle, Petersburg, Va	148
8618	Owl Brand Tobacco Plant Guano.	Davie & Whittle, Petersburg, Va	149
8405	Patapsco Guano	Patapsco Guano Co, Baltimore, Md	150

PLACE WHERE SAMPLED, AND MECHANICAL CONDITION OF FERTILIZER. (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid. Found.	Available Phos. Acid. Guaranteed.	Nitrogen.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Found.
												$	$
123 Kinston r...	9.68	1.36	5.00	2.67	7.67	7	6.16	7.48	7	7.38	7	32.90	35.24
124 Washington r	11 66	1.01	5.36	2.67	8.03	7	4.44	5.39	5	7.83	8	28.30	30.15
125 Newbern r...	11.44	1.20	5.83	2.60	8 43	8	4.32	5.24	5	5.61	5	26.20	27.87
126 Magnolia r...	11.36	0.42	5.12	2.80	7 92	8	2.50	3.04	3	4.16	4	19.60	19.80
127 Lumberton r.	13.36	1.24	7 18	2.13	9.31	8	1.68	2.04	2	2.91	2	14.80	17.00
128 Franklinton r	12 53	1.36	6.87	2.84	9.71	8	1.79	2.17	2	2.17	2	14.80	16.99
129 Gibson r.....	15.85	1.82	8.72	3.38	12.10	12	---	----		----	----	10.80	10.89
130 Gibson r.....	12.95	1 48	7.00	2 65	9.65	8	2.03	2.46	2	2.22	2	14.80	17.79
131 Mt. Airy r....	13 88	2.03	7.27	3.03	10 30	8	1.77	2.15	2	1.83	2	14.80	17.12
Salisbury r...	9.85	4 86	5.32	3 61	8.93		1.72	2.09		2.05			15.94
132 Shelby r.....	11.08	2.05	6.60	4.39	10 99	10	---	----		---	----	9.00	9.89
133 Newbern r...	10.38	1.46	3.15	2.80	5.95	4	5.32	6.46	8	8.58	7½	33.50	32.02
134 Newbern s...	10.27	2.69	1.92	5.00	6.92	2¾	6.17	7.49	7¾	5.26	5	29.18	32.46
135 Mt. Olive r...	12.88	3.85	8.16	3.87	12.03	13	---	----		----	----	11.70	10.83
136 Laurinburg s.	11.73	2.65	6.50	2.48	8.98	8	2.19	2.66	2½	2.71	3	17.20	18.24
Washington s	11.89	1.41	6.60	1.75	8.35		1.82	2.21		2.49			16 19
Beaver Dam s	10.74	1.89	6.65	2.00	8.65		2.07	2.51		2.42			17.23
Greensboro s	9.15	2.76	6.24	2.22	8.46		1.49	1.81		2.51			15.19
137 Greenville z..	14.72	1.32	8.14	1.06	9.20	8	2.34	2.84	2½	3.52	2	16.20	19.75
138 Concord r....	14.37	1.12	8 09	1.60	9.69	8	1.95	2.37	2	1.48	$1\frac{4}{10}$	14.20	17.82
139 Oxford c.....	14.44	1.27	7.70	1.56	9.26	8	1.94	2.36	2	1.82	$1\frac{4}{10}$	14.20	16 76
140 Shelby r.....	14.77	0.93	6 56	2.67	9.23	8½	---	----	----	2.30	2	9.65	10.61
	12.92	1.25	4 18	4.70	8.88		--	----	----	2.17		----	10.16
141 Waco r......	15.57	1.34	10 35	2.80	13.15	13	---	----	----	----	----	11.70	11.84
142 Charlotte r ..	13.36	1.24	7.15	2.06	9.21	8	1.57	1.91	2¼	2.23	2	15.50	15.87
Wilmington s	14 22	1 25	2 29	6.25	8 54		1.65	2.00		2.28			15.57
Shelby s.....	12.47	0.86	6.55	2.59	9.14		1.81	2.20		2.25			16.64
143 WalnutCove s	12.94	1.20	7.16	2.18	9.34	8¼	1.85	2.25	2¼	2.53	2	15.73	17.24
144 Pineville s ...	11.28	4.71	7.18	1 39	8.57	8	1.97	2.39	2	1.76	1	13.80	16.17
Hickory r....	8.70	3.88	6 06	3.36	9.42		1.70	2.06		1.50			15.75
145 Nashville r...	18.18	0.58	6.05	1.61	7 66	8	1 96	2.38	2½	3.37	3	17.20	16.93
Tarboro r....	12.72	1.37	6.38	2.09	8.47		2.25	2.73		2.64			17.91
146 Wilson r....	14.46	1.10	10.08	3 60	13.68	12	---	----	----	----	----	10.80	12.31
147 Maxton s	16.03	1.50	6.78	2.45	9.23	8½	2.07	2.51	2	1.26	1¼	14.50	16.60
148 Greenville r..	15.87	1.13	8.26	2.35	10.61	9	2.25	2.73	$2\frac{6}{10}$	1.83	1¾	17.13	19 02
149 Stokesdale s..	13.58	1.61	7.25	3.17	10.42	9	2.10	2.55	$2\frac{6}{10}$	1.78	1¾	17.13	18.30
150 Washington r	14.47	1.24	4.73	4.19	8 92	9¼	2.15	2.61	2½	1.74	1¼	16.58	17.08

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8484	Pee Dee Fertilizer	Darlington Phosphate Co., Darlington, S. C.	151
8458, 8654	Peruvian Mixture	American Fertilizing Co., Norfolk, Va	152
8579	Piedmont Dissolved Bone Phosphate.	Mt. Airy Manufacturing Co., Baltimore, Md.	153
8625	Piedmont Guano for Tobacco.	Mt. Airy Manufacturing Co., Baltimore, Md.	154
8367	Pine Island Ammoniated Phosphate.	Quinnipiac Co., New York, N. Y.	155
8408, 8511, 8651, F 8760	Plow Brand Raw Bone Superphosphate.	Walton & Whann Co., Wilmington, Delaware.	156
8638	Plow Brand Raw Bone Superphosphate for Tobacco.	Walton & Whann Co., Wilmington, Delaware.	157
8406	Pocomoke Superphosphate	E. B. Freeman & Co., Norfolk, Va.	158
8635	Premium Dissolved Bone	Richmond Guano Co., Richmond, Va.	159
8636	Premium for Tobacco	Richmond Guano Co., Richmond, Va.	160
8529	Progressive Farmer Guano	Durham Fertilizer Co., Durham, N. C	161
8449	Prolific Cotton Grower	Goldsboro Oil Co., Goldsboro, N. C	162
8454	Prolific Truck Grower	Goldsboro Oil Co., Goldsboro, N. C	163
8547	Quickstep Bone Phosphate	Wooldridge Fertilizer Co., Baltimore, Md.	164
8455	Raleigh Standard Guano	N. C. Cotton Oil Co., Raleigh, N. C	165
8463, F 8789	Rasin Acid Phosphate	Rasin Fertilizer Co., Baltimore, Md	166
F 8785	Reese's Dissolved Phosphate of Lime.	Jno. S. Reese & Co., Baltimore, Md	167
8522	Reese's Pacific Guano	Jno. S. Reese & Co., Baltimore, Md	168
8590	Reliance Ammoniated Superphosphate.	Walton & Whann Co., Wilmington, Delaware.	169
8429, 8443	Richmond Brand Guano	Jas. G. Tinsley & Co., Richmond, Va	170
8482	Royal Dissolved Bone	Royal Fertilizer Co., Charleston, S. C.	171
8512, 8413	Royal Potato Guano	F. S. Royster, Tarboro, N. C	172
8491, F 8771	Royster's High Grade Acid Phosphate.	Old Dominion Guano Co., Norfolk, Va	173
8393	Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass	174
8593	Sea Gull Ammoniated Guano	Patapsco Guano Co., Baltimore, Md	175
8556	Slingluff's Pure Dissolved Bone	Boykin, Carmer & Co., Baltimore, Md	176
8490	Special Compound for Cotton, Corn, Peanuts, and Grain	F. S. Royster, Tarboro, N. C	177
8605	Special Meal Compound	Goldsboro Oil Co., Goldsboro, N. C	178
8415	Special 7 per cent. for Potatoes and Early Truck.	Imperial Guano Co., Norfolk, Va	179
8594, 8630	Special Truck and Plant Fertilizer,	Durham Fertilizer Co., Durham, N.C.	180
8409	Standard Bone Phosphate	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	181
8549	Standard Cotton Grower	Edm'd Alexander & Co., Norfolk, Va	182

	Place where Sampled, and Mechanical Condition of Fertilizer. (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Avail. Phos. Acid. Found.	Available Avail. Phos. Acid. Guaranteed.	Nitrogen.	Equivalent to Ammonia. Found.	Equivalent to Ammonia. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Guaranteed.	Relative Seaboard Value per ton of Unmixed Ingredients. Found.
													$	$
151	Wadesboro *r*	11.31	1.57	6 19	2.95	9.14	8	2.14	2.60	2½	1.03	1	15.20	16.54
152	Wilson *r*	12.94	0.81	5.81	2.41	8.22	8	1.75	2.12	2	1.85	1½	14.30	15.18
	Rockingham *r*	13.85	1.07	7.71	0 66	8.37		2.00	2.43		1.84			16.18
153	Pineville *r*	9.77	0.84	5.97	4.29	**10.26**	10½	---	---	----	1.08	1	10.45	**10.31**
154	Reidsville *r*	10.14	1 05	5.67	2.71	8.38	8	2.08	2.53	2½	3.00	3	17.20	17.63
155	Wilmington *r*	14.18	4.21	2.10	7.05	9.15	8	1.87	2.27	2¼	1.73	1	14 50	16.32
156	Washington *sz*	14.75	1.71	6.92	2.81	9.73	9	1.95	**2.37**	2½	1.87	1½	16.60	17.26
	Wadesboro *xc*	12.53	3 08	4.90	3.71	**8.61**		1.74	**2 11**		1 59			**15.25**
	Maxton *r*	10.52	3.75	5.40	2.34	7.74		1.76	**2.14**		1.50			**14.66**
	Waco *r*	11.39	2.16	6.20	3.03	9.23		2.00	**2 43**		1.50			16.61
157	Henderson *rc*	11.69	1.68	7.83	1.99	9.82	9	1.94	**2.36**	2½	1.80	1½	16.60	17.25
158	Washington *r*	12.94	1.07	7.59	1.75	9 34	8½	1.76	2.14	2	1.74	1½	14 75	16.14
159	Roxboro *r*	13.80	0 26	11.99	2.82	14 81	13	----	---	---	---	----	11.70	13.33
160	Roxboro *r*	13.24	0.86	8.01	2.35	10.36	8	1.75	2.12	2	**1.55**	2	14.80	16.81
161	Durham *r*	11.28	1.36	6 49	2 51	9.00	8	1.62	**1 97**	2	2.55	1½	14.30	16.17
162	Kinston *r*	12.63	0.38	7.88	2.26	10.14	8	2.13	2.59	2½	2.79	2	16.20	19.17
163	Goldsboro *r*	10.09	0.27	5.82	1.56	7.38	7	3.86	4.69	4	7.09	7	24.50	26.86
164	Eliz'b'th City *b*	7.71	4.16	3.24	6.17	9.41	8	2.44	2.96	2¾	3.30	3	17.90	20.06
165	Goldsboro *r*	10.71	1.30	6.82	2.37	9.19	8	2.25	**2 73**	2¾	**1.78**	2	16.90	17.70
166	Monroe *r*	14.73	0.73	11 31	2.75	14.06	14	---	---	----	---	----	12.60	12.65
	Conover *r*	12.66	1.60	10.75	2.99	**13.74**		----	---	----	---	----		**12.37**
167	Thomasville *r*	12.59	0.10	11.77	4.27	16.04	14	---	---	---	---	---	12.60	14.44
168	Wilson *r*	16.52	1.55	3.65	6.48	10.13	8½	1.97	2.39	2¼	1.51	1 2/10	15.15	17.32
169	Fayetteville *c*	12.78	1.24	7.24	2.91	10.15	8	1.54	**1 87**	2	1.00	1	13.80	15.37
170	Rockingham *r*	12.59	1.39	7 10	2.10	9 20	8	1.69	2.05	2	1.44	1	13.80	15.46
	Kinston *r*	11.99	1.28	6.97	2.36	9.33		1.62	**1.97**		1.39			15.30
171	Wadesboro *r*	12.45	1.19	11.78	2 46	14.24	12	--	--	----	---	---	10.80	12.82
172	Kinston *r*	10.68	0.37	5 81	1 83	7.64	7	3.92	**4.76**	5	7.17	7	27.30	27.37
	Washington *r*	11.27	0.61	6.17	1.32	7.49		3.55	**4 31**		7.85			26.66
173	Franklinton *r*	14.78	1.39	9.63	3.23	12.86	12	---	---	---	---	----	10.80	11.57
	Concord *r*	9.65	2.17	8.39	4.02	12.41		--	---	----	---	----		11.17
174	Edenton, *r*	13.14	1.74	7.43	2 11	9 54	9	1.93	2 34	2¼	1.09	1	15.40	16.23
175	Raleigh *r*	13.30	1.16	6 95	2.24	9.19	9	1.72	2.09	2	1 52	1½	15.20	15.64
176	Greenville *r*	14.63	2 24	7.88	3.15	**11 03**	12	1.99	2.42	2	---	----	16.40	16.70
177	Elm City *r*	19 15	0.51	6.33	2.06	8.39	8	1.65	2.00	2	2.11	1½	14.30	15.26
178	Four Oaks *r*	10 68	1 92	5.32	3.25	8 57	8	1.72	2.09	2	2.16	1	13.80	15.73
179	Washington *r*	10.55	2.00	4.31	3.32	7.63	7	6.70	8.13	7	5.05	5	30.90	34.68
180	Warsaw *s*	11.98	1.84	6.58	2.94	9.52	8	3.14	**3 81**	5	3.30	3	24.20	**22.54**
	Eliz'b'th City *s*	14.14	1.96	6.45	2.28	8.73		3.51	**4.26**		3.29			**23.08**
181	Washington *r*	13.33	1.47	6.08	3.04	9 12	8	1.82	2.21	2	2.30	2	14 80	16.70
182	Edenton *r*	16.50	1.57	6.01	3.14	9.15	8	2.09	2.54	2	1.77	1½	14.30	17.12

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
8369, F 8758	Standard Fertilizer, Lister's Success.	Lister's Agricultural Chemical Works, Newark, N. J.	183
F 8755	Standard Raw Bone Soluble Guano.	Old Dominion Guano Co., Norfolk, Va	184
F 8782	Staple Acid Phosphate	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	185
8479, F 8788	Star Brand Guano	Allison & Addison, Richmond, Va.	186
8555	Star Brand Special Tobacco Manure.	Allison & Addison, Richmond, Va.	187
8495, F 8797	Sterling High Grade Acid Phosphate.	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	188
8441, F 8764	Stonewall Brand Acid Phosphate.	Jas. G. Tinsley & Co., Richmond, Va	189
8428, F 8754	Stonewall Guano	Jas. G. Tinsley & Co., Richmond, Va	190
8420	Stonewall Tobacco Fertilizer	Jas. G. Tinsley & Co., Richmond, Va	191
8465	Stono Acid Phosphate	Stono Phosphate Works, Charleston, S. C.	192
8467, 8573	Stono Complete Fertilizer	Stono Phosphate Works, Charleston, S C.	193
8493	Stono Dissolved Bone	Stono Phosphate Works, Charleston, S. C.	194
8476	Stono Soluble Guano	Stono Phosphate Works, Charleston, S. C.	195
8396	Thomas' Gold Basis Animal Bone Truck Phosphate.	B. A. Wooldridge & Co., Baltimore, Md.	196
8457	Tinsley's Tobacco Fertilizer	Jas. G. Tinsley & Co., Richmond, Va	197
8518	Tinsley's Vegetable Guano	Jas. G. Tinsley & Co., Richmond, Va	198
8419	Trucker's Favorite	Lazaretto Guano Co., Baltimore, Md.	199
8398	Trucker Phosphate	Wm. R. Griffith, Baltimore, Md	200
8401	Truck Farmers' Special Guano	Wilcox & Gibbs Guano Co., Charleston, S. C.	201
8400	Tygert-Allen Acidulated Phosphate.	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	202
8615	Vinco Guano for Tobacco	Davie & Whittle, Petersburg, Va	203
8485	Wagener & Co.'s H. G. Ammoniated Fertilizer.	F. W. Wagener & Co., Charleston, S. C.	204
8445	Walker's Ammoniated Phosphate.	Joshua Walker, Baltimore, Md	205
8481, F 8768	Wando Acid Phosphate	Wando Phosphate Co., Charleston, S. C.	206
8504	Wando Dissolved Bone and Potash.	Wando Phosphate Co., Charleston, S. C.	207
8486, F 8759	Wando Soluble Guano	Wando Phosphate Co., Charleston, S. C.	208
8632	Ward & Son's Bone Meal	S. H. Ward & Sons, Jamestown, N. C	209
8434	Wilcox & Gibbs' High Grade Acid Phosphate.	Wilcox & Gibbs Guano Co., Charleston, S. C.	210
8402	Wilcox, Gibbs & Co.'s Manipulated Guano.	Wilcox & Gibbs Guano Co., Charleston, S. C.	211
8548	Wooldridge Gold Basis Bone Truck Phosphate.	Wooldridge Fertilizer Co., Baltimore, Md.	212
8527	Zell's Ammoniated Bone Superphosphate.	Zell Guano Co , Baltimore, Md	213
8628	Zell's Special Compound for Tobacco.	Zell Guano Co., Baltimore, Md	214

PLACE WHERE SAMPLED, AND MECHANICAL CONDITION OF FERTILIZER (See page 11)	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid	Available Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Unmixed Ingredients.	
					Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
												$	$
183 Wilmington r	17 24	2.07	6.35	2 45	8.80	8	1.85	2 25	2	2.12	2	14.80	16.34
Cherryville r	16.68	2.09	6.38	2.58	8.96		1.80	2.19		2 20		....	16.40
184 Fallst n r	12.00	1 73	7.09	1.63	8.72	8	1.76	2.14	2	1.29	1	13.80	15.13
185 Lexington r	13 39	1.79	9 07	3.62	12.69	10	...	...	....	..	....	9.00	11.42
186 Elm City r	13 74	1.29	6.79	1.96	8.75	8	1.90	2.31	2	1.41	$1\frac{1}{4}$	14.05	15.75
Thomasville rc	13 46	2.02	7 24	1.81	9 05		2.05	2.49		1 50	....		16.62
187 Reidsville z	16 22	0.78	9.09	1.85	10 94	9	2.58	3.13	$2\frac{3}{4}$	1.26	$1\frac{1}{4}$	17.05	19.87
188 Franklinton r	15 33	2 33	10 43	2 57	13 00	13		...	...	...	...	11.70	11.70
Greensboro r	14.54	1.23	10.17	3 66	13.83		.	...	...	...	.		12.45
189 Kinston z	14 5?	1.49	9.32	2 72	12 04	10	...	...	.	.	...	9.00	10.84
Crouse r	13.06	1.61	9 30	3.39	12.69		....	.	.	.			11.42
190 Rockingham r	12 39	1.20	7.55	1.68	9.23	8	1.85	2.25	2	2.30	2	14.80	16 91
Crouse s	10.90	2.02	5.69	3.36	9.05		1.61	1.95		2.15			15.76
191 Washington r	12 00	1.39	7.28	1.53	8.81	8	1.99	2.42	2	2 31	2	14.80	17.02
192 Pineville r	17.69	0.87	8 90	2 86	11 76	10	.	...	....	1.42	1	10.00	12.00
193 Monroe c	17 73	1.68	7 94	1.61	9 55	8	1.64	1.99	2	1.18	1	13.80	15.35
Dunn r	16.55	2.70	6.65	1.74	8.39		2.16	2.62		1.31			16.20
194 Dunn r	16.60	1.07	9 51	3.82	13.33	12		...	....	. .	...	10.80	12.00
195 Lumberton r	18.72	1.64	7 45	2 17	9.62	8	2.17	2.63	$2\frac{1}{2}$	1 26	1	15.20	17.28
196 Eliz'b'th City s	10.91	1 36	8 34	2 82	11 16	8	5.72	6 94	7	5 45	5	31.80	34.98
197 Wilson r	10.57	1.59	6.92	2.17	9.09	8	3.46	4.20	4	2.86	$2\frac{1}{2}$	20.90	22.80
198 Enfield r	12 85	0.31	6.67	3 31	9.98	8	3.14	3 81	4	3.29	$2\frac{1}{2}$	20 90	22.94
199 Washington r	11 21	1.80	5.51	1.81	7.32	7	5.14	6.24	7	4.98	5	30.90	29.04
200 Eliz'b'th City s	10.73	1.38	5.67	1.42	7.09	$5\frac{1}{2}$	3.22	3.91	$4\frac{1}{2}$	2.49	2	19.55	19 82
201 Washington r	17.87	0.13	7 77	2.05	9.82	10	3.38	4.10	4	4.30	4	24.20	24.62
202 Washington r	11.75	1.48	11 69	3.33	15.02	14		...	...	...	...	12 60	13.52
203 Burlington s	15.39	1.25	6.75	3.44	10.19	$8\frac{1}{2}$	2.01	2.44	2	1.37	$1\frac{1}{4}$	14 50	17.37
204 Morven c	12.69	1.94	8.29	1.58	9.87	8	2.27	2.76	$2\frac{1}{2}$	1 41	1	15.20	18.02
205 Newbern r	14.78	2.14	7.18	1.35	8.53	8	2.20	2.67	2 43	1.62	$1\frac{1}{2}$	15.50	16.77
206 Wadesboro r	12.08	3 11	10.40	2.79	13.19	$11\frac{1}{2}$	..	.	..	.		10.35	11.87
Waco r	12.93	1.75	11.68	1.81	13.49		...	...	....	...	....		12.14
207 Concord r	14 05	1.02	9.16	4 03	13.19	10	.	...		1.49	$1\frac{1}{2}$	10.50	13.36
208 Wadesboro r	9.85	2.92	8 66	1.57	10.23	9	1.93	2.34	$2\frac{1}{4}$	1 75	$1\frac{1}{2}$	15.90	17.51
Waco r	11.18	3.70	7.06	2.61	9.67		1.97	2 39		1.57			16.97
209 High Point b	8.72	see fo t note				....	3.13	3.80	$3\frac{1}{2}$	...	.	19 42	23.32
210 Laurinburg r	15.82	0 82	12 00	2.45	14.45	13	...		...	.	...	11.70	13.01
211 Washington r	18.19	1.73	7.37	0.71	8.08	8	1.95	2.37	$2\frac{1}{2}$	2.22	2	16.20	16 13
212 Eliz'b'th City s	9.28	1.42	7.23	3.57	10.80	8	6.22	7.55	7	5.16	5	31 80	36.02
213 Elm City r	12.80	3.25	7.10	1.89	8.99	8	1.89	2 29	2	1.45	1	13 80	15.95
214 Reidsville r	12.34	2.64	6.49	3.16	9.65	8	1.65	2.00	2	2.23	2	14 80	16.52

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OFFICIAL FERTILIZER ANALYSES,

INCLUDING ALL ANALYSES OF 1894.

Trucking in the South,

ESPECIALLY ADAPTED TO THE NEEDS OF NORTH CAROLINA CULTIVATORS.

ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

BULLETIN NO. 112

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

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AND THE STATE WEATHER SERVICE,

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RALEIGH, N. C.

PREFACE.

The accompanying bulletin on "Trucking in the South, especially adapted to the needs of North Carolina cultivators," is another of the series of educational bulletins inaugurated by the Experiment Station to disseminate information among the farmers of North Carolina upon subjects of practical importance. The bulletin was prepared primarily for the eastern section of the State, and the dates of cultivation, etc., are intended to be suitable for that particular region. It is believed, however, that useful hints can be gleaned that will be of service in all parts of the State.

The mixed fertilizers, as given in the appendix, are also adapted to market trucking when earliness is an important factor. The mixtures are high grade fertilizers and should be used in liberal amounts, but the application per acre is subject to change when the cost of the application is a serious consideration, and where it is not expected to force the growth for an early market.

As the bulletin especially interests the East, complete copies are only sent to parties living in that region. The full table of contents is inserted on the following page, from which the scope of the bulletin can be ascertained, which will be sent to any one in North Carolina who will make application to the undersigned.

H. B. BATTLE, *Director.*

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* Pages 31—96 will be sent free upon application to parties in North Carolina by addressing Dr. H. B. Battle, Director, Raleigh, N. C.

TRUCKING IN THE SOUTH

ESPECIALLY ADAPTED TO THE NEEDS OF NORTH CAROLINA CULTIVATORS.

By W. F. MASSEY, Horticulturist.

INTRODUCTION.

Before the introduction of commercial fertilizers, and the completion of railroads North and South, the market gardening or trucking business of the South could never have been developed. Forty years ago no one thought of growing vegetables for market away from the immediate vicinity of a large town, where a plentiful supply of stable manure could be always obtained. Even after the use of artificial fertilizers had become common among farmers, and their use had developed the cultivation of some of the varieties of vegetables, such as peas and potatoes, on cheaper lands away from the immediate neighborhood of the large cities, the gardeners in those places could not be brought to believe that as good results could be had from the use of fertilizers as with stable manure. And so until a very recent period the gardeners around the large cities thought that for their use the stable manure was essential. But even these men have at last found out that the same results can be had more cheaply by the use of commercial fertilizers, in connection with a leguminous crop buried in the soil, to take the place of the organic matter in the stable manure.

The rapid growth of our cities long ago demonstrated that the little gardens on their outskirts could not produce the needed supply. As the transportation facilities increased, the production of early vegetables naturally moved southward, and their production had already assumed quite respectable proportions around Norfolk before the war. The abolition of slavery made it possible to hire large numbers of laborers in the vicinity of the Southern coast towns, where the freed negroes congregated, and with an abundance of cheap labor, quick transportation, an abundance of fertilizing materials, and a favorable climate and soil, it is no wonder that the business of market gardening has made wonderful progress in the South, and particularly in the South Atlantic States. North Carolina has by no means lagged in the development, and our trucking interest has become one of the leading agricultural interests.

Many men have gone into the business of growing vegetables who have had no special training as market gardeners, and many of

these have been successful with the crops they have grown, while others, failing to realize the great difference between gardening and farming, have failed to get paying crops, because they did not understand the business, and tried to garden an area too large for the capital employed on it. The late Peter Henderson laid it down as a rule, in cultivating the high-priced garden lands around New York City, that a man, to be successful, must have a cash capital, outside his land, of $300 per acre. This was, of course, for places where labor was expensive and rent of land so high that every foot of land was in close crop, taking much hand labor.

While of course the southern gardener, with his cheaper soil, cheaper labor, and more extensive use of horse power in his work, does not need to have as large a capital as this, it is nevertheless true that, in market gardening, as in farming, our people are inclined to spread over too large an area for their capital. The trucker who starts with a cash capital of less than $100 for each acre he cultivates in vegetables, will be taking a serious risk of failure. If his crops are as good as his neighbor's with means, his margin will be smaller if he buys on credit, and the failure of one of his crops will be a more serious matter to him. There is no kind of soil culture in which a man needs ready cash so much as in trucking, and none in which a skillful man can use so much money profitably. It is with the hope that we can aid some of our people in acquiring this skill that this bulletin has been prepared. The writer has had the advantage of a long and varied experience in all the departments of practical horticulture, and believes that he can make suggestions of value to those already engaged in market gardening, as well as to those who desire to engage in it.

Soils for Trucking.

The coast plain of North Carolina is naturally the best region for the cultivation of the market gardener's crops, aside from the earliness of its climate, and the facilities for water transportation. A truck farm must of necessity be on land level or nearly so, for ease of culture and retention of fertility. It needs, too, a mellow, sandy loam for the greater part of the crops, and one abounding in decomposed vegetable matter.

These conditions are found nowhere else in the State to the same extent as they are on the eastern coast. The light clay loam ridges, level sandy flats, and black peaty bottoms, which are all found there, often all on the same farm, offer the variety of soils for the best success of different garden crops. The man who would start a market garden on steep clay uplands or on a cold clay flat would be simply inviting failure. There are, of course, limited areas of fine garden land in all the upland sections of the State, but for extensive market garden operations, the business, at least so far as early vegetables is concerned, must always be limited to the level, sandy

plain of eastern and southeastern North Carolina. On this plain, too, the cow pea, on which the market gardener of the South must in a large measure rely for the humus to supplement his commercial fertilizers, grows to a perfection not known elsewhere.

But while the eastern coast is the natural locality for the gardener who seeks to supply the early Northern demand, there are other sections of the State which have adaptations for certain crops, for the growth of which the eastern section is to a great extent unfit. These are the fall and winter crops of cabbage, the main late summer crop of Irish potatoes, and the celery crop. For these the upper Piedmont and the mountain sections are specially adapted, though skillful gardeners will be able to produce them fairly well in the east.

Preparation of Land for Trucking.

There is no one point upon which our people most commonly err than in supposing that any piece of mellow land, suited to trucking, but not rich, can be made at once to produce a paying crop of vegetables of all kinds by the excessive use of fertilizers upon it. While such crops as the English peas may be produced on such land, the man who would undertake to grow a crop of early cabbage on it would be pretty certain to fail to get a paying crop. No matter how good the soil is for the ordinary farm crops, it will not be in condition to give the best results in garden vegetables until after several years of good culture and heavy fertilization. And while the commercial fertilizers contain all the elements of plant food that stable manure has, and in better proportion, the vegetable matters in the manure not only have a good mechanical effect on the land, but they keep up the formation of nitrates in the soil. The commercial fertilizers lack this, and the lack must be supplied if we keep up the productiveness of the land. Decomposed vegetable matter from the forest will do this, but this is an expensive thing to collect and haul.

The most rapid and economical way in which the vegetable matter can be gotten in the land is by the growth of some leguminous crop on the land. For this purpose there is no crop in this latitude equal to the Southern field or cow pea. This plant, in common with all the pea family, has the power of capturing the nitrogen from the air and fixing it into the soil for the succeeding crop. Its heavy growth above ground, the greater part of which, too, comes from the air, furnishes a larger amount of vegetable matter than would be gotten in the heaviest dressing of stable manure.

The field pea gives the southern gardener a great advantage over those in a Northern climate, because it can be grown after his early crops are shipped, as a preparation for his winter ones, and he can thus do as much in the way of supplying his soil with organic matter and nitrogen in one season as the other man can in two, and can

at the same time raise a valuable forage crop, for as the soil becomes well stored with vegetable matter we do not think that it is advisable or economical to bury the whole growth. The growth of tops will be of more value for feeding stock, and by the careful saving of the manure he can return to the soil nearly as much of manurial value in a much more available condition. The keeping of dairy cattle in connection with the market garden is thus made practicable and profitable The manure thus made is also a great help in the saving of commercial fertilizers. On highly manured truck lands the growth of crab grass, which comes in naturally after the removal of crops late in summer, is another valuable aid in the feeding of stock. Wherever there is a ready sale for dairy products it will always pay to keep cows for the consumption of the forage that can be grown so heavily on these lands, and to use the utmost care in the saving of all the manure.

Manures and Fertilizers.

While it is doubtless true that for most vegetable crops the manure of the stable and barnyard is the best possible, few gardeners, particularly Southern truck gardeners, are so situated as to be able to get all that they need, and in some places it commands a price that makes it a less economical manure than the commercial fertilizers. Then, too, there are some crops that are actually better grown with commercial fertilizers, as the Irish potato, for instance, with which the use of the manure of cattle is apt to encourage the growth of the fungus causing "scab." But, as suggested above, every truck grower should endeavor to make all the manure that he can by the profitable feeding of stock.

When fertilizers are depended upon exclusively, the green manuring with the cow pea becomes of the utmost importance, and until the soil is well filled with humus, it will pay to plow them under. When a heavy growth of pea vines is to be plowed under, they should always be allowed to get their full growth and to die upon the land before plowing them down. They have then done all that they can for the soil, and in dying there is no loss of any appreciable fertilizing value, since they part with the water only. There is then, too, no risk of a dangerous fermentation, as when a heavy green growth is plowed under in hot weather.

In using the manures from the stable or barnyard, the truck gardener needs to have them piled and reduced to a fine condition by slow fermentation. Coarse and fresh manure that a farmer can use on a grass sod profitably will not do for him. Thorough decomposition is essential to get the mass into a state in which it will give up its plant food most readily. Piling and composting, while seldom profitable for the grain farmer, is of importance to the gardener. Those who are so situated as to be able to get the sweepings from paved city streets can profitably use this material for composting

with their stable manure, and the black mold from the forest can also be used to advantage. These materials should be put in thick layers with the manure in a broad and flat-topped pile, which should be chopped down perpendicularly, and thoroughly mixed by turning several times before using. The object is to keep up a slow fermentation and to check injurious heating, thus getting the pile into the condition of a black moist mold, suitable for using in the hill or broadcast, as occasion may dictate.

Artificial Fertilizers.

Mixtures almost innumerable are now offered by the manufacturers of commercial fertilizers, each claiming special qualities and advantages for different crops. Some go to the extent of offering a special brand for each different vegetable crop. This is largely unnecessary, though some variation of the different elements of plant food is desirable for different crops. The potato crop, for instance, demands more potash than the cabbage crop, and less nitrogen, and the same rule will apply to most other garden crops, according to their growth below or above the ground. The three elements of food which plants get by means of their roots, and which are most apt to be deficient in cultivated soils, are nitrogen, potassium, and phosphorus. Plants use nitrogen in the form of organic sources, nitrates of lime, soda, or potash; potash in this or some other salt of potash; and phosphorus as phosphoric acid or a phosphate.

Lime and its Uses.

Lime is one of the essential elements of plant food which must be in the soil to enable any plant to grow. But for all the purposes of plant food many of our arable soils contain an almost inexhaustible supply. But lime has been found to have value in the soil aside from its use by the plant as food direct. The chief of these uses, in a soil well stored with decomposing vegetable matter, is in promoting the growth of the nitric ferment organisms that change parts of this organic matter into nitrates, and thus make the nitrogen or organic matter available as food for plants. Lime also corrects injurious acidity in soils, aids in the breaking up of insoluble compounds of potash, thus rendering that base available to complete the work of the nitric ferments, and also has an important mechanical effect in the soil, making a clay soil more mellow and a sandy one more compact. On lands cultivated in trucking crops and heavily fertilized, and with frequent green manure crops buried in it, an occasional liming has a very beneficial effect. This will be particularly noticeable on the cabbage crop. While shell marl will to some extent have the same action, the insoluble form of the lime, as it exists in the marl renders its action less marked and immediate than that of freshly water-slaked lime.

Land Plaster or Gypsum (Sulphate of Lime).

The action of plaster on any given soil can only be learned by trial. On sandy soils near the coast it is seldom so beneficial in its action as upon the clay soils of the interior. We have seen very decided benefit, on some soils, from the use of plaster as a top dressing on the crop of early "Snaps," or string beans. It is also sometimes very efficient in promoting the growth of clover or peas. But as there are many soils on which plaster seems to have no effect whatever, nothing but experiment can determine its value on a given soil.

Commercial Fertilizers.

As we have stated, the three constituents of plant food that are most generally deficient in our old soils are nitrogen, potash and phosphoric acid. In ordinary farm crops it is practicable, by the use of the leguminous crops, like clover and peas, to get a sufficient amount of nitrogen from the air, but this, while a valuable help, will not supply it in sufficient amount for immediate use for the purpose of growing the early vegetable crops of the southern market gardener. For many of his crops an artificial combination of nitrogen, in a readily available form, is of the greatest importance. In the absence, then, of a plentiful supply of well-rotted stable manure, he must resort to some commercial source of nitrogen. While the nitrogen in commercial nitrate of soda is in the most readily available form, it is evanescent, and in practice it is found better to mix with it some more slowly available form, as in organic matters like fish scrap and cotton-seed meal, to keep up the supply through the season of growth. Of these we give the preference to the cotton-seed meal, since it is more accessible to all growers in the South. Cotton-seed meal has the further advantage that it supplies also some potash and phosphoric acid. The common source of this last is the phosphatic rock of North and South Carolina. This is changed into a soluble state by being dissolved in sulphuric acid, making what is commonly called "Acid Phosphate." This is probably the cheapest form in which phosphoric acid can be had in the South.

Potash exists in a very soluble form in hard wood ashes, and the ashes of cotton-seed hulls are particularly rich in it. Where these last can be had they furnish the best possible shape for potash. But as they can seldom be bought by the gardener in sufficient quantity, he is compelled to resort to some other combination. The great source of potash now is found in the various potash salts mined in Germany and imported here under the names of Kainit, Sylvinit, and others. The crude forms of the salts are seldom available for the use of the market gardener on account of the large proportion of common salt which they contain. This prevents the heavy application of the crude article, as we would thus get for most crops an injurious amount of the salt. The concentrated

forms of the muriate or sulphate of potash are the forms in which gardeners use the potash salts, except for asparagus, on which the Kainit does as well. For most garden crops the muriate of potash will usually be found best.

Mixing Chemical Fertilizers.

There are innumerable brands of mixed fertilizers offered by the men who make a business of preparing these in different proportions for various crops. But oftentimes it will be found easier and more economical to mix the ingredients, which can be purchased for this purpose, bearing in mind that the more concentrated form in which he can get these, generally the cheaper he will get the essential constituents, potash, phosphoric acid, and ammonia (or nitrogen). Most manufacturers of fertilizers always give the percentage of nitrogen in a mixture as ammonia, as this custom has grown universal from early practices. Ammonia is a compound of nitrogen and hydrogen, which has the properties of an alkaline base and unites with acids to form salts. The sulphate of ammonia and nitrate of soda, are two of the most concentrated forms in which we can get nitrogen, and is a valuable form for the truck gardener's use. One can readily ascertain the relative cost of the nitrogen, potash or phosphoric acid in a fertilizing ingredient by dividing the price of the ingredient in the market by the percentage of these it contains, and thus find in what shape it is cheapest. A highly concentrated form makes a great saving at times in freight and handling. The farmers of North Carolina are far more secure in buying the commercial fertilizers already prepared than are the farmers of many other States, owing to the strict inspection laws, which are rigidly enforced by the Agricultural Department, and the constant and accurate analyses that are made of every sample offered for sale in the State by the Experiment Station. If any sample of a chemical for the preparation of a fertilizer is sent to the Station, the true percentage of the element claimed can always be ascertained by the farmer before purchasing in quantity, if previous correspondence be conducted with the Station.

There are many advantages in mixing the constituents at home, as in that way particular ingredients can be used for special crops, or advantage be taken in using local supplies. The purity of these ingredients can also be ascertained, and their proportion in the mixture can be altered to secure any desired percentage. When buying the ingredients they should always be purchased on a special guarantee. When mixing at home the materials should be as dry and fine as possible, and should some be lumpy, as in the case of the potash salts or nitrate of soda, the lumps should be mashed before attempting to mix. A clean floor should be used for the mixing, and the ingredients, weighed out in the proper amounts, should be poured on top of each other in alternate layers. Two

hands with hoes, on opposite sides of the heap, can mix the layers rapidly, at a cost not to exceed fifty cents per ton. When mixing a small quantity a tight wagon-body is very convenient to use. Where large quantities of fertilizers are used, and sufficient power can be had, it will pay the grower to provide the necessary machinery for mixing the ingredients. A variety of formulas for different crops, using different ingredients, can be seen by referring to the Appendix.

Rotation of Crops.

While there are some crops, like onions and Lima beans, that seem to do as well or better by being grown continuously on the same land year after year, the systematic rotation of crops is, as a rule, as important in the garden as on the farm. While no excretory process has been discovered in plant life, it is nevertheless true that, though kept supplied with all needed plant food, plants of most kinds will not continue to give the best results, year after year, on the same land. They seem averse to feeding on the refuse of their own growth that inevitably accumulates from the harvesting of the crop.

Then, too, the different crops require the elements of plant food in varying proportions. Some require larger proportions of potash in comparison to the nitrogen than others, and we can make our fertilization more economical by a rotation, for the potash is not going to leave us, like the nitrogen does, and we can take advantage of this to some extent in the following crop. Soils differ, too, in their capacity for retaining manures. Clay soils have a much greater power for absorbing and retaining plant food than sandy soils. This is due to the fact that clay rather retards the decomposition of manures, while the decomposition is more rapid in a sandy soil. Unless the sandy soil is immediately underlaid by a retentive clay subsoil its lower absorptive power will cause it more rapidly to part with the plant food by leaching. It will be found, therefore, to be much more important to keep up a rapid and regular rotation of crops on the sandy soils, which from their nature are best adapted to early vegetable crops than on a clay soil. While the experiments at Rothamsted have shown that a crop like wheat may be continuously grown on a clay soil without deterioration, the fact has been well settled by experience that with most truck crops a change of soil is of vital importance. We very much doubt that in our climate there is any soil that would give the same results that were obtained in the moist climate of England.

Dr. A. Oemler, of Georgia, in his valuable book, "Truck Farming at the South," gives the following points on a rotation of crops that we heartily approve:

"First: To have a crop which succeeds another as dissimilar in composition and the demands it makes upon the soil as possible. Second: Never to have plants of the same family succeed each

other; for instance, melons should not follow cucumbers, tomatoes should not follow egg-plants or Irish potatoes; beans should not succeed peas, or *vice versa.* Third: Tuberous plants should not be allowed to follow plants of the same character. Fourth: Root should not succeed to root crops, as turnips, beets, etc. Fifth: Deep or tap-rooted plants should not succeed others of similar growth. Sixth: to make the heaviest applications of manure to such crops as require most, as cabbage, onions, etc., and to have other crops succeed these requiring less, as tomatoes, egg-plants, etc., so that the whole farm may be gradually brought to the same degree of fertility."

As has been frequently noticed by practical gardeners, there is often as much need for a rotation of manures as of crops. A piece of land that has been continuously dressed with stable manure will be benefited by a change to commercial fertilizers and *vice versa.*

Seeds and Seed Sowing.

There is no point in horticulture in which so great an improvement has been made in this country as in the quality of the seeds offered for sale to the gardener. The art of seed-growing is better understood, and the requirements of our climate have been studied by practical men. The writer can well remember when dealers prided themselves on the fact that the seeds they offered were "English" seeds, not knowing that with many plants American grown seeds are infinitely superior for our use. In the days of the old "Early York" cabbage we remember with how much of uncertainty the seed were sown, not knowing whether any of them would make a solid head. And not until the "Early Jersey Wakefield" cabbage was developed from the English Wakefield, by continuous selection in our climate, did growers fully realize that for certainty of crop it was necessary that cabbage seed for American use must be grown in America.

The question of climate in its relation to the production, has been more closely studied of late years, and no well-informed gardener now supposes that all the seeds he needs can be best grown in one climate. The fact that many sorts of garden seed are better for the production of the earliest crops when grown in a high latitude, led to the notion that all seeds produced in a northern latitude are necessarily superior to those grown in the South. There is no greater error in horticulture. There are many seeds that do not reach their best development, as crop producers, in any given locality, when they are grown far north or south of the latitude where they are to be sown. While the market gardener can seldom afford to grow his own seeds, there are some which he can generally produce to advantage, if unable to get them from a reliable grower in his own latitude and elevation, for elevation above the sea has the same effect on many crops as a high latitude. In this class should be

placed such seeds as those of Indian corn, egg-plants, tomatoes, Lima beans, okra, cucumbers, melons, and a few others. It is also a well established fact that the late fall grown crop of Irish potatoes produced in the South makes far better tubers for growing the early spring crop from than those produced in a northern latitude, a fact that is rapidly revolutionizing the practice of gardeners, not only in the South but in the North as well.

One of the chief reasons for the common failure to grow good crops of sweet corn for table use in the South has been the fact that our people so commonly get the Northern grown seed for planting. Indian corn, more than most other plants, fails to do its best far south or north of the place where the seed is grown. Indian sweet corn, grown and carefully selected for seed in our latitude, will produce far better results here than any seed we can get from the North. Garden peas, snap beans, and some other seed, we had always better have of Northern growth. The radish seed sold by our best seedsmen are produced in France, experience having proved that they can be better grown there than here. But there is one point in regard to seeds that is not sufficiently understood by our gardeners generally. This is what we may call "pedigree." Thoroughbred seeds are of as much importance to the gardener as thoroughbred horses are to the race-course. It takes a long course of skillful culture to establish a "race" in plants that will with certainty reproduce itself. There is a constant tendency in all plants to revert to an original, and, generally, an inferior type. Hence the necessity for skill and care on the part of the seed-grower. Experienced planters understand this so well that they are more concerned about the strain from which their seeds come than about the relative percentage of vitality even, though both are of importance. No class of business men are so minutely careful as our well-known seed men to guard the purity and vitality of the stock they offer. The sharp competition between them to get and keep the best strains of the various garden seeds, and to retain the trade that they could only have acquired by such care, is the best guaranty that the gardener can have. The dealer who gets and keeps the trade of a large number of market gardeners around him, must of necessity sell a good article. Experienced gardeners will often be found buying a certain strain of a common vegetable from a certain stock, and from no other, though they may possess the same vitality, because they know the value of pedigree. All the little Extra Early garden peas, for instance, are the same kind of pea, though branded with various names by the dealers; but the stocks of some are more sought for by market gardeners because they have found them to be more carefully kept to the type than some others, or better "rogued," as the term is, that is, the plants that show a tendency to revert to an inferior type are kept pulled out of the crop. The stocks from which our leading seedsmen get their seeds are nowadays of such general purity that anyone can usually get just what he wants if he deals with a man of reputation. In most things it costs

a southern market gardener too much to attempt to save seeds, but if he grows nothing else he should always grow his own seed potatoes, and, in fact, should usually grow a surplus, as there is always a demand for them at planting time.

Duration of Vitality in Seeds.

There is a great difference in different plants in this respect. Some seeds quickly lose their vitality, while some retain the power to germinate for a very long time. Lettuce seed are not usually ranked among those which retain their vitality many years, but when well kept they may be trusted for several years. Beet seed will retain their germinating power for at least ten years under favorable conditions; cabbage, kale, radish, tomato, spinach, turnip, asparagus, broccoli, cauliflower, beans and peas, are all good for four years or more; while pumpkin, cucumber and melon seed will keep for ten years. Onion and leek seed are not to be relied upon after the second year, and their vitality is much weaker even the second. But it must be borne in mind that these figures refer to seeds that are kept under the most favorable conditions. In the moist climate of our Southern coast the duration of vitality will usually be found to be shorter, and no one should trust onion seed here after the lapse of a year in our climate. Melon and cucumber seeds are more fruitful when two or three years old than when perfectly fresh, but make a less vigorous growth of vine. In all other cases perfectly fresh seed should be preferred. In all cases get seed from a seedsman of established reputation, and do not trust to seeds put out on commission at country stores.

Time for Sowing.

All seeds usually sown in the open ground vary in their requirements for growth. The vital principle in seed requires three conditions to induce germination—moisture, a proper degree of heat, and access of the oxygen of the air. They all have a minimum temperature at which they will start into growth, some at a much lower point than others. Onions and English peas will germinate at a temperature but little above the freezing point, while the seeds of corn, cucumbers and other tender plants will rot if exposed to moisture at such a temperature. It is evident then that care must be used in sowing seeds at times when the temperature is suitable to the nature of the plant. The practice of soaking seed in water to hasten germination is seldom advisable, for unless the soil is in exactly the proper state of warmth and moisture at sowing more harm than good will be done. If, at the time of sowing, the soil is dry it is always better to compact it over the seed, either by tramping with the foot on a row after sowing (as Mr. Peter Henderson used to insist upon), or by rolling. But if the soil is moist either of these practices will do more harm than good.

As a rule all garden seeds should be sown in drills and not broadcast. Exceptions to this will sometimes be found profitable, as I have found it profitable to sow an early spring crop of strap-leaf turnips broadcast, and at times to scatter seeds of radishes among other slower growing crops. But the rule holds good that the best crops are to be looked for from sowing in rows, careful thinning and clean cultivation.

No market gardener should ever sow seeds by hand. There are now several effective garden seed-drills, and no one can afford to sow seed by hand. The depth at which seeds are sown is governed by the character of the soil, the time of the year, and the moisture present. In a general way it may be said that the size of the seed should govern the depth of planting, but there are exceptions even to this, for the seed of the Lima bean, one of the largest seeds sown, should be but barely stuck in the soil, eye down. The old rule is to cover the seed about three times its thickness with the fine mellow soil, but in many light soils this will hardly be sufficient for many things. Seeds need deeper covering in sandy than in heavy soils, and the soil over all seeds should be made as fine as possible.

Quantities of Seed per Acre.

Books on gardening give tables of quantities of seed necessary to sow an acre. These are usually only approximate, and in most books the quantities named are excessive. But it is far better to err on that side than to use an insufficient amount. Some seeds germinate with very feeble shoots, and it is important to have the seeds thick, so that they may be able to force their way out of the soil. The quantity to be used will vary of course with the distance the rows or hills are apart. There are 43,560 square feet in an acre, and the number of hills can be readily ascertained by multiplying the number of feet the hills are apart each way to get the number of square feet for a hill, and divide the number of square feet in an acre by this to get the number of hills in an acre.

The following figures, given by Mr. Peter Henderson, will be found useful as a guide, but few growers ever use so large quantities: Beets, 5 to 6 lbs. per acre; snap beans, 2 bushels: cabbage, 1 ounce for 2,000 plants; cucumbers, in hills, 2 to 3 lbs.; kale, 3 to 4 lbs.; watermelons, 4 to 5 lbs.; onions, 5 to 6 lbs.; onions, for sets, 30 lbs.; onion sets, 6 to 12 bushels; peas, 2 bushels; potatoes, 10 to 12 bushels; radishes, 8 to 10 lbs.; spinach, 10 to 12 lbs.; tomato, 1 ounce for 1,500 plants; turnips, 1 to 2 lbs.

The Use of Glass in Trucking and Market Gardening.

There is no point in gardening in which our growers are so deficient as in the skilful use of glass. They are too much addicted to the use of substitutes, in the shape of plant cloth, under the impression that it is cheaper. I have had a wide experience in the use of

glass, and have tested the so-called substitutes, and know that they are not only less effective than glass, but in the long run far more costly. It is hard to understand the tardiness of the Southern gardeners to appreciate the use of glass, since they are usually wide awake to any improvement. Some seem to imagine that glass is only useful in the more severe climate of the Northern and Middle States. But a little experience of the great advantages to be attained by a skilful use of glass, would soon satisfy any progressive southern gardener that glass can be made as profitable in all parts of the South as in the North.

COLD FRAMES AND HOTBEDS.

The most common use of glass in the garden is in the construction of cold frames and hotbeds. The difference between a cold frame and a hotbed is that the cold frame is merely a frame to hold the glass sashes over a rich bed of soil, for the protection of some plants in winter and for the hardening off of tender plants which have been started in a hotbed or greenhouse. The hotbed, on the other hand, is provided with some means for artificial heat, usually an excavation for holding a mass of fermenting manure, though sometimes a furnace is placed at one end and a flue run through a hot-air chamber under it, making what is known as a fire hotbed. This last is but a poor compromise for a greenhouse, which can be built nearly as cheap, and is vastly better. In fact, the small narrow greenhouse has now almost superseded the hotbed of any kind for all the purposes for which a hotbed can be used, being much more convenient and effective.

To construct a cold frame we use glass sashes made for the purpose, three feet wide by six feet long, in which the glass is placed, lapping like the shingles on a roof. These sashes can be had in Raleigh for $1.50 each, ready glazed and primed, and if carefully handled and kept painted will last many years, and in the long run will be found far cheaper than the plant cloth, and at the same time will be vastly better than cloth for all the purposes of the gardener.

For these sashes we construct a frame of boards. The one at the back or north side is 12 to 14 inches wide and the one in front 10 inches, so as to give a slope to the glass to carry off the water in time of rain. The frame should face south or southeast. The frame may be as long as desired, but, for convenience, it is best, perhaps, to put not more than 25 sashes in one frame, though I have used 1,000 sashes in lines of 50 on a frame, with a cart road between each line of frames, always using, as will be explained later, twice the area of frames that I had of sashes. Some gardeners simply get the sides of the frame in line by nailing the boards to a line of posts, and use no cross bars, but a frame so constructed, while convenient to spade up and prepare, is a very inconvenient one to manage. By far the best plan is to dovetail a strip, three

inches wide, into the front and rear board every three feet of the length of the frame, but do not nail it fast. It can then be readily knocked out when preparing the soil in the frame. In the centre of this rafter a thin strip of the same thickness as the sash should be nailed, so as to form a slide for the sashes to slide up and down for airing the frame, it being of course understood that the sashes are laid across the frame the six-foot way. This will give us a bed nearly six feet wide and as long as convenient.

The frame yard should be in a well-sheltered place, and if not naturally well sheltered should have a high board fence or some other protection, not only as a protection from cold but from high winds of any sort, for nothing is so provoking as to have a sash blown away in a windstorm. In windy localities near the coast I have found it necessary to run a narrow strip midway the entire length of the frames, under which the sashes could slide, to prevent their being blown away. To make a hotbed of the frame, all that is necessary is to dig out the interior into a pit two feet deep in which to place the fermenting manure. This manure should be fresh horse manure mixed with plenty of leaves or straw, and should be piled and turned daily for a week or more before using, and then be packed two feet deep in the pit and well trodden all over, so as to have a uniform heating, and should be covered with four inches of light, rich soil, in which the seeds are to be sown when the first rank heat is over. But the hotbed is an inconvenient, troublesome and expensive structure, in the long run, as compared with the narrow, cheap, fire-heated greenhouses which have now so largely taken its place with all progressive gardeners.

Plenty of sashes in cold frames are indispensable in a well-ordered market garden, both for growing some crops under for the winter market, and for hardening off plants like tomatoes, egg-plants, etc., that have been started in the greenhouse; but for all purposes for which the hotbed can be used, the greenhouse is far better and more convenient, and in a series of years will be found cheaper. Of the management of frames and greenhouses we will treat when treating of the culture of the various crops that require their help.

HOW TO MAKE A CHEAP GREENHOUSE.

The most economical greenhouse for the trucker is probably the low, narrow house recommended many years ago by the late Peter Henderson. This kind of a greenhouse is made with the same sashes that are used in the construction of the cold frames. The house is made by setting posts in line, four feet apart, to make the side walls. These side walls are four feet high and ten feet apart, this being the width of the house. The tops of the posts should be cut to the slope of the roof, and a plate nailed thereon, on which the sashes are to rest. This plate should project inside and out so as to allow of a gutter being formed on its outer edge, for it is desirable to have

a tank inside to catch the rain water from the roof for watering purposes. The ridgepole for the roof should be cut so that the ends of the sashes which are to form the roof will rest on a shoulder and come flush with the top. Each alternate pair of sashes is screwed fast to the ridgepole at the top and to the plate at the side wall, thus forming rafters for the support of the ridgepole. The other pairs are to be hinged to the plate at the bottom and held in place at the top by a hook, or by an iron strap punched with holes to catch on a pin on the ridgepole, so that they can be propped open to admit air to the house. If the house is to be heated by an ordinary brick flue it should not be more that 40 to 50 feet long. A door wide enough to admit a wheelbarrow should be in each end, and a walk through the centre under the ridgepole. Benches are to be made on each side for holding soil or for placing flowerpots or boxes. These benches and the whole house can be constructed of rough lumber, with the cracks battened. The house should run north and south, and at the north end a shed should be made for a work-room, and into which the furnace door is to open, so as to keep the smoke and dust from the house. The furnace is made of brick, in a pit four feet below the level of the house. The furnace should have an ordinary cast-iron door and ash pit, and the grate surface should be 18 by 30 inches. An arch is turned over the fire-box, and the flue is built from the rear end on a sharp ascent to the level of the floor of the house. It should then be built along under the side benches, on a slight ascent, the whole length of the house, across the farther end and back to a chimney at the same end it started at. The first ten or fifteen feet should always be made of brick, the remainder of six-inch terra cotta pipe. The furnace should never be made smaller than this, so as to hold a good body of coal to keep up a slow and steady fire during the night without attention. The furnace may be made to burn wood, and in that case no grate bars will be needed, as the fire can be entirely regulated by a draft hole in the door. But a coal-burning furnace is far better, where convenient. For seed-sowing purposes it is better to have the flue entirely boxed in under the benches, but in this case hinged doors should be made along the walk, so as to let more heat out in the house when needed.

A house of this description can be built here now all complete, 10 by 50 feet, for less than $100, and no market garden is complete without some such structure. Where a large business is done, and means are at hand, it will be better to build larger houses, in a more permanent manner, and have more than one, so that different temperatures can be maintained for the requirements of different plants. In this case it will be best to heat the houses with a boiler and the circulation of hot water or steam in iron pipes. For large houses this will be more economical in the end than a smoke flue, but much more costly at the start. But the heat is much more congenial from hot-water pipes or steam than from a flue and is better distributed.

Northern gardeners use hot water and steam-heated houses now on a very large scale for forcing vegetables and fruits under glass in winter, and their products bring a much higher price than the same products from the open air in the far South at the same time. Last spring cucumbers from the Arctic climate of Vermont sold for more money than the same vegetable did the same day from the open ground in southern Louisiana. The Vermont growers are about as far off from the New York market as the North Carolina growers, and must use much more expensively-built houses than our growers would have to use and vastly more fuel to keep up the same temperature. We are very strongly of the opinion that in this part of the South the methods used so profitably in the North now for the production of the various vegetable and fruit crops out of season could be adopted with far greater profit than there. But skill in greenhouse management, and particularly in winter forcing, is only to be obtained by long experience, and no one can hope to succeed at it until they have attained this experience, or have the aid of trained men. It is the purpose of the North Carolina College of Agriculture and Mechanic Arts to do all possible in the training of young men for this work.

In our climate we can produce some things, like lettuce, for instance, in winter, by the aid of the simple cold frame, which the Northern gardeners grow much more expensively in fire-heated houses. Of this we will treat in the chapter on this crop. Our Newbern gardeners make it pay to ship lettuce from the open ground in spring, but they could make it much more profitable if shipped in winter. The market as far South as Baltimore and Washington is largely supplied in winter with lettuce from the Boston greenhouses, which our growers could supply at a much better profit. I have dwelt thus largely upon the use of glass because, from an experience of more than thirty years in handling all sorts of glass structures for the cultivation of plants, I am satisfied that there is no line of work in horticulture which offers so great prospect of profit to the growers in the upper South. Profit is always greater in those lines that require special skill and capital, and, therefore, the work is rarely overdone. There are many things in the line of floriculture which a gardener of skill could add to his work and thus increase his profit and keep his houses always at work. The limits of this bulletin will not allow me to enter into the details of greenhouse management, but we hope to make this the subject of another of our educational bulletins at some future date. This bulletin is to be devoted to the methods of culture of the various crops which engage the attention of market gardeners here. The insects that infest them might well be included, as well as the diseases that afflict them, but this would increase its bulk too largely. My colleague, Prof. McCarthy, has already issued bulletins* on the subject, and to these I must refer.

*Bulletin No. 84, "Some Enemies of Truck and Garden Crops," also Bulletin No. 78, "Some Injurious Insects," can be had upon application to the Director.

VARIETIES OF VEGETABLES AND THEIR CULTURE.

It is our purpose here to treat mainly of those kinds of garden vegetables that can be most profitably grown in the South for northern shipment, but at the same time we will call attention to some which our home markets in the South sadly lack and which may well engage the attention of our growers, for, in the anxiety to grow products early for the North, our home markets often are supplied with late products which a proper degree of attention and skill would enable us to supply at rates often more profitable than those obtained for the crops shipped North.

Asparagus.

There is no vegetable grown that has uniformly proved so profitable to the grower as the asparagus crop. The time and expense involved in getting an asparagus plantation into successful production prevents the temporary growers, who are so apt to rush into an annual crop, and thus cause gluts, to their own disgust and that of the regular trucker as well, from planting this crop.

GROWING THE PLANTS.

Asparagus plants are grown from the seed and should be a year old before planting in their permanent quarters. Two-year-old plants are sometimes recommended, but well-grown one-year plants are far better. To grow the plants a piece of very fertile and mellow soil is best, in fact, to produce first-class roots a rich soil is essential, and it is hardly possible to overdo the manuring and preparation of the seed-bed. The common practice of those who grow these plants for sale is to sow the seed far too thickly, the object, of course, being to get all the plants possible out of the land. It is, therefore, always best to grow your own plants, and to grow them well, for one well-grown plant will give better results than half a dozen stunted ones. Sow the seeds as early as the ground can be gotten in good condition in February, in rows about a foot apart. Thin them if too thickly crowded, and transplant the thinnings to other rows. They are very easily transplanted in an early stage of growth, and the transplanted ones often surpass the others in growth. It is important to keep the seed-bed clean and well-worked, for if neglected and allowed to get stunted the plants will be inferior and it will take a longer time to get the plantation into a profitable state of productiveness. It will require 10,000 plants to set an acre, and two pounds of good seed ought to produce them. But in the matter of seed it is always best to be on the safe side and use a plenty, so as to be prepared for accidents. Therefore it will be better to sow three pounds of seed for each acre to be set in plants.

PLANTING.

An asparagus plantation is expected to last twenty years or more. The preparation of the soil should, therefore, be of the most thorough

character. A warm, sandy soil is the best, and one which has for some years been cultivated in garden crops and heavily manured is greatly to be preferred to a fresh soil, no matter how heavily manured specially for this planting. But at no period of its growth must the crop be allowed to lack for manuring, for only in very rich soil can first-class shoots be grown. There is far more in fertility of soil in asparagus culture than in the variety. Any variety will make good crops with heavy manuring; no variety will do so without it. The land should be prepared in the most thorough manner, and furrows opened four feet apart, by going twice in a furrow with a turning plow, and then cleaning it out with shovels to a depth of eight inches at least, if the object is to grow white asparagus, but if green shoots are wanted the roots should not be more than three or four inches under the surface. Some markets demand that the shoots be cut under ground, so as to have them blanched, but the tendency now is toward the more tender, green asparagus. Another advantage in not having the roots too deep is that they will start earlier than those set deeply. In the bottom of the furrow scatter coarse raw bone at rate of 1,000 pounds per acre, the slow decomposition of which will tend to maintain the fertility of the soil longer than most other fertilizer. The plants should be set with their roots spread out in a natural position, and about a foot apart in the row. Some growers insist upon much wider planting, even as far apart as three by six feet, but I have never failed to get just as good asparagus at the distances given, and a great deal more per acre, and at less expense. It is heavy manuring which makes fine asparagus, and not square feet. In setting the plants be careful to cover the crown of the root not more than two inches at first, as the first shoots from the young roots are not strong enough to force through a deep mass of earth. Gradually fill the furrows as the shoots advance in growth. Thorough clean culture is essential at all times. As the plants get into a blooming age much trouble will be saved by digging out all the seed-bearing plants, as they tend to fill the soil with young plants. These are generally few in number, as the male plants are usually in a large majority. It is of no use to manure the plantation in the fall, when the roots are dormant. All manuring should be done in late winter, just before the plants begin to shoot. Use heavy dressings of stable manure, if to be had, otherwise use a high grade fertilizer (See Appendix for formulas), and on alternate years apply half a ton of kainit per acre. This will furnish the salt which the plant seems to like, and potash, too. The salt is of more use in keeping down weeds than as manure for the plant. It can stand an amount of salt that the weeds cannot. If well cared for the cutting may begin the third season.

CUTTING AND SHIPPING.

The roots should be cut well down to the crown of the plant, but care must be used to run the knife down close beside the shoot, so

as to avoid injury to the other shoots. A knife made for the purpose is best. A machine is used for bunching, in which the shoots are placed with the tops all pressed evenly against a board, then clamped tight by a treadle and two flat ties of rafia or bast tied around. The butts are then cut evenly with a sharp knife and the bunch is ready to pack.

The bunches should be packed upright in crates just deep enough to allow a layer of moss under and over them.

Beans (Snaps). (*Phaseolus vulgaris.*)

"Snaps" are one of the leading crops of the Southern trucker. They need the lightest and driest land of the farm, and the warmest exposure. They are more cheaply grown than any other crop of our gardens, and occupy the land but a short time, making a good succession crop to the early cabbage crop, without any more fertilization, and, when the crop is gathered, the vines can be plowed under to fertilize the land and be followed by a crop of crab grass for hay. As the profit in them is mainly in the earliest, it pays the gardener to run some risk in order to be in among the earliest. It is therefore common to begin the planting by the middle of March, although there is serious risk that these early sown ones may be cut off by frost. But if they survive they pay better than later plantings. When planted on land specially prepared for this crop manure of some kind must be used in the furrow. Some gardeners consider fresh stable manure best, but this is seldom available, and we consider it a mistake to use it on a leguminous crop like the bean. Beans do not need heavy manuring, and a dressing of 500 pounds per acre of a high grade fertilizer (See Appendix for formulas), well mixed in the furrow, will be sufficient for them. Two furrows should be lapped over the manured furrow, the ridge thus made rolled flat and the seed drilled on this flattened ridge. A skilled hand can sow the bean in a shallow furrow very well in the absence of a seed drill, but drills of various kinds, both for hand and horse power, are essential to every well equipped truck farm. An ordinary cotton-seed drill will sow beans as well as anything else.

SHIPPING.

The green beans should be shipped in well ventilated bushel crates. The pickers must be instructed to pick the pods as soon as they are of fair size and before they are old enough to show the bulge of the seed. They must use both hands so as not to disturb the roots of the plants. The packing in the crates must needs be done with care, as the beans shrink in transit and the crates should be full on arrival. A light sprinkling before packing will help in this matter, and the packing should be regular and firm and not a promiscuous tumbling into the crate.

VARIETIES.

For the earliest planting the Mohawk is still popular on account of its hardiness, but it is soon superseded by those of better quality. Of the green-podded sorts the Extra Early Valentine we consider the best. It is very early and productive, and is free, to a great extent, from the rust that attacks the wax-podded sorts. Of the wax or yellow-podded sorts we have as yet found none that have so many good qualities as the Gold-Eye Wax bean. It is not so handsome a pod as the old Golden Wax, but as it is usually free from the rust which has driven that fine variety out of use, it is a safer bean to use. Those who want a wax bean should use this. There are many other sorts in the catalogues, but as we are not preparing a catalogue we simply name varieties that we can recommend.

GENERAL TREATMENT.

The culture of snap beans is so simple and so soon over that it is not necessary to go into detail. The rows being the proper distance apart for the use of a horse cultivator that tool is all that is needed. We have found it a great advantage in some soils to give a top dressing of land plaster along on top of the rows as soon as the plants were well developed and before blooming. When the crop is gathered the vines should be at once plowed under, either for some succession crop, or for the natural succession crop of crab-grass hay, which is one of the most valuable crops of the southern market garden.

Lima Beans.

Henderson's Bush Lima, on account of its earliness and dwarf character, can be treated as the crop of snaps is, and it ought to be a profitable crop in the South, though it occupies the land the whole season. When no longer profitable to ship in the green state, the ripe beans may be gathered until frost, and will find a ready sale in the home markets in the winter. We have never found the large pole Lima a productive or profitable bean for the South. Dreer's pole Lima is better in the South than the large Lima. There is a bush form of this which we have not tried enough to recommend. We consider it promising, however.

Beets.

The early turnip-rooted varieties are the only kinds of beets that are of importance to the southern trucker. Though growing mainly on or near the surface, the beet, on account of its long tap root, requires a mellow, deeply-worked soil, and one in which the fertilizing matters are very uniformly distributed. Coarse, lumpy manure makes ill-shaped roots, and it should never be used. Soil that has been for years well manured and cultivated in vegetables is best for the beet crop, and a good crop can seldom be made on land freshly taken in vegetable culture, no matter how well manured.

While quite a hardy plant, beets are easily destroyed by a freeze when just germinating. But the market gardener must always take some risks in order to be in among the earliest. We, therefore, sow beets among our earliest crops in February, and stand ready to replant if destroyed by a late frost. Half a ton to a full ton of high grade fertilizer (See Appendix for formulas) is needed for the best results, according to the previous manuring of the land. The rows should be wide enough apart to admit of horse culture. Furrows are marked with a plow and in them the fertilizer is scattered and covered with furrows from each side. The ridge thus made is flattened with a roller and the seed drilled with a garden-drill on these flattened ridges. We have found it a good practice to sow a few early radish seeds mixed with the beet seed. These come up at once and mark the rows. and are pulled out of the way for sale before they harm the beets. The so-called seed of the beet is really a fruit, with many germs or seeds, and thinning is an important matter. This is done very much in the same way that cotton is thinned. Frequent cultivation is needed and the rows must he kept clean by hand weeding. One bar plowing and two cultivations with one hand-hoeing will usually make the crop. About four pounds will sow an acre.

SHIPPING.

Early beets are shipped before they are full grown and while yet tender. They are fit to ship as soon as they are about three inches in diameter. Pull them and trim the leaves to about three or four inches from the roots, and pack neatly and closely in ventilated barrels and cover the top of the barrel with bagging. They will command a better price if tied in flat bunches by their tops, three or four in a bunch, before packing in the barrels.

VARIETIES.

For family use we know of no better early beet than the old Bassano, but its big top and light color condemn it for the market grower. For many years the Extra Early Egyptian beet has been the standard sort with the market gardeners, because of its earliness, small top, and dark crimson color, and it is still largely grown. But it is a beet of very poor quality, and soon gets hard and stringy. The Eclipse beet has of late years rapidly attained popularity, and is superseding the Egyptian, being a handsome, globular beet of good color and quality. Lentz Extra Early Blood Turnip beet has also gotten popular with gardeners by reason of its size, good quality, and small top. These last two we consider the best.

EARLY CABBAGES.

The early cabbage crop is one of the greatest importance to the southern market gardener, and its increased consumption seems to keep pace with the increase in production as well as any other crop

grown. Many years ago, when we depended upon Europe for many of our seeds, and the old Early York was the standard early cabbage, there was nothing more uncertain than the heading of an early cabbage. But since we have learned that for American planting home-grown cabbage seeds are essential, and the Early Jersey Wakefield cabbage has been developed, the crop is as reasonably certain as any. There are still in the South some gardeners who imagine that the European-grown seeds are the best, and there are dealers who cater to this impression, for the imported seed can be sold much cheaper than the home-grown ones. But the gardener who imagines that a very low price for seeds is consistent with good quality will be badly deceived. Seeds from a well-bred race, that has been kept pure by long selection, always costs more than carelessly-grown seeds, and are worth to the grower many times the difference in the price.

GROWING THE PLANTS.

Early cabbages are always planted in the fall in the South, and well-grown plants at the right time are essential to success. While a good-sized plant is necessary at planting time in November, care should be taken not to make the sowing of the seed too early, for if these early plants get a check in their growth they will run to seed in the spring instead of making heads. It is the opinion of experienced gardeners that this running to seed is not so much the result merely of too early sowing, but of a check by drought or some other cause. The proper time for sowing seed for the early cabbage crop is from September 25th to October 10th. In some seasons they may be sown later, but several sowings within these dates will usually give the plants of proper size. We prefer several sowings rather than to depend on the results of but one, for the earlier ones in some seasons may not be in as good condition at planting time as those sown later, while, if an early cold sets in, the earliest ones may be the better ones.

The careful gardener will also guard against possible loss of plants by making still another sowing of seed in the cold frames in late November, and keep them protected by the sashes on cold nights until February, when they will make a useful succession crop to the first planted ones if they do well. This last sowing should be made of a larger growing variety, like Fottler's Brunswick, or Succession, which do not do so well for the early fall sowing. The early fall sowing should be made on a bed of fairly fertile soil, but no manure or fertilizer should be used, as a very rapid growth would make the plants too tender, and a sudden check in this rank growth would throw them into seed-making. The soil into which they are to be transplanted later cannot be made too rich, but in the seed-bed at this season we want a moderate and sturdy growth, so that the transplanting to a highly-enriched soil will be no check to them, and they will be in a better condition to go through the hard weather that January may bring.

Make up beds for the seed sowing about four or five feet wide and sow the seed in rows across the bed about a foot apart. The seed should be sown thinly so as to give room for stocky growth. The beds can be thrown up with a plow about a week ahead and let lie for the weed seed to germinate, and in raking them level these weeds will be destroyed and give less trouble thereafter. Those sown in the frames we usually scatter broadcast and transplant, as soon as large enough to handle, about two inches apart all over the bed. This will give much better plants than if they were left as sown. If not transplanted the seed should be sown in rows in the frames, too, but the rows need be but three inches apart. There are so many accidents of weather and insects to guard against that the careful gardener will always use a superabundance of seed in preparing for this crop.

The late Peter Henderson, in his book, "Gardening for Profit," estimates an ounce of seed to secure 2,000 plants. Now, there are several times that many seed in an ounce, and even with the best of seed we seldom secure all the plants in good shape that germinate. We must make large allowance for the fall grasshoppers, with their enormous appetites, and the reverses of the weather. So the amount of seed advised by Mr. Henderson is, in our experience, not far from right for safety. We have sometimes lost every seed of an entire sowing, from no fault whatever in the seed, but from insects and unfavorable weather. A baking rain should be at once followed by a loosening of the soil in the bed, whether the seeds are up or not.

THE SOIL AND ITS PREPARATION.

In the first place let it be well understood that the soil for early cabbages cannot be too rich. The plants are gross feeders, particularly of nitrogenous manures, and a continuous and rapid growth is essential to earliness and a good crop. Land freshly cleared from a forest growth, no matter how fertile it may be naturally, nor how well manured it may be, will not grow the best crop of early cabbage. It needs years of culture in vegetable crops to fit the soil for the best results in cabbage growing. The best soil for the early cabbage crop is a high, mellow loam, inclining rather more to clay than too sandy, but quite a sandy soil will make good crops if the clay subsoil is not too far away. Such land may be quite thin at first, but it can be more rapidly brought into good condition for this crop than the deep, black soils of a lower lying land. Good early cabbages are seldom grown on black bottom lands. These lands are bad for wintering the plants and make soft-headed cabbage. But no matter how fertile you may have gotten your uplands, it will never do to assume that you can grow a good crop of early cabbage without further heavy dressings. Other crops may at times make their growth on what the previous crop has left in the soil, but early cabbage never. While, in case of necessity, cabbage may be grown, by heavy manuring, on the same land that grew the same

crop the year before, it is always best to rotate the crops and not plant the same land two years in succession if it can be avoided.

We have never yet been able to discover the limit to which manuring may be profitably carried with this crop. The use of lime as the soil gets well supplied with vegetable matter is an important matter in the cultivation of the cabbage crop. It should be applied about once in five years, at the rate of fifty bushels per acre. If the soil has a clay bottom it should be deeply broken by the subsoil plow whenever the land comes in cabbage. The more lavish the manuring and the better the previous preparation, the better always the crop.

TRANSPLANTING.

In drawing the plants from the seed-bed in November they should be at once placed in tubs containing enough water to cover the roots, in which they should be taken to the field, and set while dripping wet. We prefer to run the rows east and west, put most of the fertilizer (see Appendix for formulas) in the laying-off furrows and bed on them. Then set the plants near the base of the bed on the south side. The plants should be set so firmly in the soil that the tip of a leaf will break off before the plant can be pulled out by taking hold of the edge of the leaf, and they should be set well in the ground so as to cover the entire stem, which is the most tender part. The beds should be from two and a half to three feet apart, and the plants about fifteen inches apart in the row. When plants are plenty it is a good plan to set them half this distance apart, to guard against accidents during the winter, and in spring cut out the surplus plants to dispose of for greens, when the other plants need all the room.

CULTIVATION.

No plant that the gardener grows requires more rapid and thorough culture than the cabbage. The plants being set during November will not need any cultivation until they begin to grow strongly in February. As soon as growth begins the rows should be barred off with a small plow and the soil at once leveled with the cultivator. The cultivator should then be used once or twice and the cultivation completed with the plow by bedding the soil back to the plants. I have found it of great benefit at the "laying-by" cultivation to run a plow without mouldboard deeply through the center of the middles. A light subsoil plow or a common bull-tongue will answer. The remainder of the fertilizer should be used alongside the rows in barring off, to be covered by subsequent cultivation.

HARVESTING AND SHIPPING.

A light, sharp hatchet is the best tool for cutting cabbages. The shipping should begin as soon as the hearts of the cabbages are firm and solid. A few of the outer leaves should be left on, so as to make

them pack nicely in the barrels. Ventilated barrels are generally preferred for shipping, but large crates holding a barrel are coming more and more into use for cabbages and a few other crops. Our growers think that a small-headed Jersey Wakefield, that will take nearly seventy-five heads to the barrel, makes a more profitable shipping cabbage than the larger Charleston Wakefield, that will fill a barrel with fifty heads. The Succession and Fottler's Brunswick will fill a barrel with eighteen or twenty heads.

The packing should be done as firmly as possible, so that there should be no material shrinking in transit. Put heads of same average size in each barrel, cover with bagging and mark the number of heads in each. When the cabbage crop is off, the gardener who has the increasing fertility of the soil in view will at once plow in a good sowing of cow peas on the land, to be cut later, with the crab grass that will inevitably spring up among them, for hay to feed the stock, for stock of some kind should always be kept on a truck farm to profitably use up the refuse from the crops and to furnish manure.

VARIETIES.

The earliest cabbages are invariably of the conical-headed class. The introduction of the Jersey Wakefield marked an era in early cabbage culture in this country, and soon caused the old Early York to be abandoned by all progressive truckers. The great fault of the Wakefield has been a lack of uiformity of type. When we first began to grow this cabbage, twenty-five years ago, the best samples would give many round heads that were always later and reduced the value of the crop materially, and delayed the subsequent use of the land. Now, after years of careful selection, we have various strains of Wakefield and other conical-headed sorts that are uniform in type and far more valuable than the original Wakefield. The largest heading of these is the one known as the Charleston. This comes very true to type and is of good size, but it is later than the small type.

Of the smaller type of conical-headed cabbages there are two that have become favorites with the market gardeners of the South. These are Tait's Extra Early and Tait's Extra Early Pilot. The first has long been largely grown around Norfolk, but the last is a more recent introduction. It is, in our experience, the best of the early cabbages for our use, as many more can be planted on an acre than of others, owing to its slim, upright growth, and it is of the size that has been found to sell best in barrels. The Winningstadt was long a favorite with us when the Wakefield was so badly mixed, but it has the disadvantage of making such wide spreading leaves that fewer can be grown on an acre. The heads are remarkably solid, and, while at the North it is stated to be much later than Wakefield, we have not found much difference between them and the ordinary type of Wakefield in this respect in the South. We have

often commenced to cut both the same day. But it is later than the two sorts last named, which we consider the ideal early cabbages.

Of the flat-headed second early type there is little choice between Fottler's Improved Brunswick and Succession. Both are fine and very sure to head. If there is any difference we would give preference to Succession. These varieties should never be sown in the early fall, when the early sorts are sown, as they will be apt to run to seed. Sow them in cold frames in November and transplant for wintering in the frames.

LATE CABBAGE.

The crop of late cabbage is a far more difficult one to grow in the South than the early crop. The climate in summer and the multitude of various insects, together with the diseases that infect it, make the culture of the late fall and winter crop a matter of much uncertainty in all the eastern plain country of the South Atlantic slope. In the western mountain region of this State the soils and climate are peculiarly well adapted to this crop, and it has assumed great importance there as a crop to ship to the coast cities of the South.

The great difficulty in the culture of late cabbages in the South has been, we think, that growers in the warm coast regions have followed too closely the practices that are found best in the North, but which are not best in our climate. While it is extremely difficult here to have cabbages to head in the early fall, it is much more easy to have a good late winter supply, if the proper conditions are observed. Most people sow the seeds of their late cabbage too early, and then have to keep them through the long summer. If the plants sown in the spring survive at all they are in such a stunted state that no good cabbages can be made from them. In the mountain country the common Northern modes of sowing and culture are all right, but in all the warmer sections we must adopt a different plan. Here seed for late cabbage should not be sown before the first of August. While in sowing seed for the early crop in the fall it is desirable not to have the seed-bed too rich, the opposite must be the case with those for winter heads. The seed-bed should be away from the farm buildings, as insects are more troublesome there. A good plan is to burn over a bed, just as it is done for tobacco plants, and then manure it heavily. The seed are to be sown in rows and encouraged to grow as rapidly as possible. Dusting the plants as soon as they appear with tobacco dust and air-slaked lime we have found to be the best means to ward off the "flea beetle."

The plants should be planted in a naturally moist clayey soil, made as rich as possible. Cultivation should be rapid and thorough, and every means should be used to keep the plants growing as fast as possible. As it is important that they should begin to turn in for heading early in November, a dressing of nitrate of soda alongside

the rows will be useful. Then early in December they will be well headed. If they are then bent down where they grew, with the heads turned towards the north, and the soil is well banked over the stalk and the base of the head, they will keep well.

For this crop we prefer to use Fottler's Brunswick and Premium Flat Dutch. The first-named will head earlier, and the last will keep longer. Constant care will be needed with this crop to keep insects in check.

For the common "green worm," the larva of the cabbage Plusia and Pieris butterflies, the best remedy we have tried is a mixture of salt and air slaked lime in equal parts sprinkled over the plants. If a dressing of nitrate of soda is applied alongside the rows in cultivating the growth will be so much encouraged that the plants will, in a measure, outstrip the worm. The harlequin or terrapin bug can be destroyed by kerosene emulsion in almost full strength, but it is a severe dose for the plants, and hand-picking is best on a small scale. Or a row of mustard may be sown between the rows and the bugs will leave the cabbage for the mustard, when they can be destroyed with pure kerosene. Winter cabbages always find a ready sale in our home markets, and might be made a profitable adjunct to the garden.

Cauliflower and Lettuce.

While fairly good cauliflowers can be grown in the coast region of the South in the same way in which the early cabbages are grown, the crop is by no means a certain one. The plant is more tender in its nature than the cabbage, and a severe check in its growth, while it may not destroy the plant, will cause it to "button," as the gardeners say, that is, to make a little abortive head prematurely, that is perfectly worthless. For this reason it is always better to grow early cauliflowers in cold frames associated with the winter crop of lettuce.

The seed for this purpose should be sown not later than the 15th of September. Early in November they should be set in the frames, six plants to each 3 x 6 foot sash, and the rest of the space in the frame set with Tennis Ball lettuce six inches apart, from seed sown a week earlier than the cauliflower. The soil in the frames should be of the richest possible description. The glass should be put over the plants at once and shaded with bagging until the plants recover from the transplanting. Then the shade must be removed and the plants exposed in all sunny and warm weather, but the sashes should always be drawn over them in frosty nights. The object is to keep all in a state of healthy growth, but not to keep so close that a very tender growth will be made, as they may be seriously injured then by a sudden cold snap.

The lettuce should be well headed and ready to ship by Christmas. Lettuce should be shipped in tight barrels and covered with heavy bagging. Trim off all defective leaves and rinse each head

in water in packing. Pack neatly in layers in the barrel, heads upside down and well tucked in, so as to give no room for jostling.

After the lettuce is out of the way give the cauliflowers a good working over, and then expose them to the full air on every favorable opportunity, so as to get them well hardened to the outer air by the time they begin to get their leaves against the glass, and, finally, by the latter part of February, at least, strip the glass off of them entirely and use it on other frames for tomatoes, cucumbers, or other crops. The cauliflower should be well headed and cut out by the last of March. The cauliflower is naturally a seaside plant and does not reach its best perfection far away from the coast. They require a very rich soil and an abundance of water. The plants in the frames should, therefore, never be allowed to suffer for water, and the glass should be stripped off in every warm rain during the winter. If snow falls let it lie on the glass, as it will protect the plants from the cold which is apt to follow the clearing off.

VARIETIES.

The only varieties of cauliflower we have found worth growing in frames are the Early Erfurt and the Snowball. The last named is the best and most certain heading sort we have ever grown. It leaves nothing to be desired in an early cauliflower. For growing in the frames with the cauliflower we have found no lettuce better than the strain of Tennis Ball known as the Boston Market lettuce. When the frames are devoted to lettuce alone the sort called the Big Boston is probably the best. The Black-Seeded Simpson is a quick-growing sort of fine quality, but it does not make a close head, and hence does not sell so well. For home use we prefer it to any other. The lettuce known as All the Year Round is one of the best for open-ground culture, and for spring planting the Hanson is fine, as it stands warm weather well. But no sort of lettuce is of any value here after warm weather sets in finally.

CUCUMBERS.

The cucumber crop is one of importance to the Southern trucker, and a profitable one when gotten into market in good color and early. It is a crop in the forwarding of which in frames a much greater profit can be realized than from the mere planting in the open ground, for by the use of glass we get them into the Northern market as early as those south of us, who depend only on climate, and ours, getting to market in a fresh condition, will bring better prices. While cucumbers are largely grown in all the trucking sections of the South from seed planted in the open ground, and enormous quantities are shipped, the usual crop being about 1,000 bushels per acre, they have not been regarded by our truckers as a very profitable crop, owing to the fact that before the crop of one section is marketed the warm weather has brought on the cucumbers of the

growers a little north of the section, and their fresher condition shuts out those south of them.

It is by forwarding the plants, then, that we can best avoid this. The outfit of sashes and flower-pots for forwarding cucumbers and cantaloupes, which are treated in a similar way, on a large scale is a costly item, and this fact makes the practice all the more certainly profitable, as it prevents the competition of those who are ever ready to rush into the culture of a crop that does not cost much to grow. Aside from the sashes we must have a supply of pots of the four-inch size. These are now made in large quantities by machinery at very low rates, and can be had, delivered in lots not less than 1,000, for about one cent each, and, if properly handled, will last many years and be useful for many crops.

In preparation for forwarding the plants in pots, a full supply of compost for filling the pots must be prepared the previous fall by cutting grass sods and getting black mold from the forest, and piling them in layers with well rotted manure, putting about two-thirds sods and leaf mold and one-third manure. This must be turned and well mixed several times during the winter, and before using should be passed through a gravel screen to make it uniform and to remove all lumps and rough material. The pots are filled with this compost and set closely and perfectly level in the frames, seed are scattered in each pot, and more compost is sifted over them to cover the seed. They are then well watered with a sprinkling watering-pot until the entire soil in the pots is wet through, and the sashes are put on and kept close until the seeds germinate. Great care must be taken to exclude mice from the frames, and careful attention must be given to watering. As the seeds germinate careful attention must be given to airing them on sunny days by slipping down the sashes more or less, according to the weather. If left shut up closely on a warm sunny morning the temperature may get so high under the glass as to seriously injure or destroy the plants. Equal care must be given to protect the glass in case of a severe night by having a plentiful supply of pine or other straw at hand to cover the frames. As the plants develop, thin to two plants in a pot, and as the weather grows warmer give more air and gradually inure them to full exposure.

PLANTING.

The land into which the cucumbers are to be planted should be well prepared beforehand, and the hills marked out with a plow five or six feet each way, and a shovel or two full of manure or compost placed in each check just as in planting seed in the open ground. The plants in the pots should now be well watered, and then knocked out of the pots without breaking the ball of soil, and carried to the field in flat boxes. The knocking of a plant out of a pot is a very simple thing to an expert, but beginners are apt to make an awkward job of it. Have flat-topped stakes driven into the ground near

the frames. A man takes a pot, turns it upside down on the palm of his left hand, with the stems of the plants between his fingers; then, with a smart tap of the edge of the pot on the top of the stake, the ball falls into his hand. The plants are set in holes made in the compost in the hills and the earth is packed closely around the ball, and the whole is covered a little deeper than it grew in the pot. The subsequent culture is just the same as if seed had been planted in the hills. I have set plants in this way in bloom without the loss of a plant.

In raising the crop from seed in the open ground the only difference is to plant the seed in the hills a little earlier than it would be safe to set out the pot plants. Cultivation must be rapid, as the vines will soon stop it. The crop is laid by by bedding up to the plants with a plow. The same treatment will answer for muskmelons, and we will, therefore, not repeat it for that crop. The hills should be made with a shovelful or two of compost of manure and black mold from the woods and a handful of high-grade fertilizer (see Appendix for formulas) sprinkled over it and covered with soil upon planting the seeds.

VARIETIES.

The catalogues give long lists of cucumbers, but the truckers still adhere mainly to the White Spine. A good strain of this variety is all that need be desired.

CELERY.

There has of late been a great increase of interest in the celery crop in this State. This is not a crop with which we can hope to compete with the Northern growers for the Northern markets, but there is a large market in all the Southern cities for good celery, which our home growers should supply. Accounts published in the agricultural journals from time to time in regard to the great development of the cultivation of celery around Kalamazoo, Michigan, have led many to inquire whether celery may not be grown, at least for our home markets, at a profit in competition with celery brought all the way from Michigan to North Carolina.

We would remark in the beginning that climatic conditions forbid that we should compete with the Northwestern growers in the production of blanched celery in summer. Celery is a native of a cool, moist climate, and cannot be made to develop here in our hot summer weather. But, on the other hand, our mild winter climate gives us an advantage in the culture of the winter crop, which makes it easy to grow here at a small part of the expense necessary at the North, where the crop must be lifted and stored for winter. At the prices at which celery usually retails in the markets of Raleigh and other Southern cities, over $1,000 worth can be grown on an acre of suitable and well-cultivated land, the retail price here being nearly double this. The tall celery sent here in summer from Michigan is

grown on a peculiar black mucky soil, much of it absolutely boggy, to such an extent that horses cannot be used, and all the work of the crop is done by hand-power. The cultivators there are Hollanders, who delight in such a soil. While this black muck land grows the most showy celery, it is really of inferior quality to that grown on good clay soil in the cooler season of the year. Celery is one of the most expensive and laborious of crops that can be grown, and any attempts to grow it without a liberal expenditure in the shape of manure and labor will certainly result in a failure to get a crop worth marketing. In this latitude it should always be grown as a second or third crop on the land for the season. It succeeds best on land that has been very heavily manured for the early crops, and has a surplus left over for the celery. No matter how rich your land may be in your estimation, you cannot grow good celery without further and liberal manuring. The land used by the Kalamazoo celery growers is black muck from three to ten feet deep, and yet they use immense quantities of manure upon it profitably. In a house-garden here the land intended for celery should be planted in early Irish potatoes or onions. These will come off in time to plant a crop of snap beans and use them before it is time to plant the celery finally. The first to middle of September is plenty early enough to make the celery plantings in this latitude. Of course the plants must be gotten ready sooner. If it is to be grown on a large scale for market, it can still follow on the same land from which the early Irish potato or onion crop has been gathered, and on which field peas have then been sown. The peas can be mown in August and cured for cow feed, and the stubble turned over and prepared for the celery.

RAISING THE PLANTS.

If only a few plants are wanted, it is much cheaper to get them from the North in June or July, and transplant them into a cool, moist soil a few inches apart to develop to the proper size for final transplanting. The plants can now be bought from the growers at the North for $2.00 per 1,000, and at this price are cheaper than can be grown here on a small scale. When a large lot of plants are wanted, prepare a bed of moist soil, as mellow in character as can be had. Use large quantities of manure and make it as fine as possible by chopping, rolling, and raking. Then mark out shallow rows across the bed and scatter the seed thinly. Cover only so much as may be done by beating the bed over with the back of a spade. The sowing should not be done earlier than May. As soon as the bed has been sown and packed over with the spade, cover it with jute bagging or old gunny sacks. These, spread on the soil, will keep the surface moist and enable the seed to germinate freely. Care must be taken to lift the cover as soon as the seeds begin to germinate, and gradually inure them to the light by propping the bagging up on sticks to shelter them from the rays of the sun. A

little shade will be a great help in carrying them through the summer. Screens made of building laths nailed an inch apart, and placed on posts high enough to work under, make an admirable shelter for the beds.

TRANSPLANTING.

As soon as the plants are an inch or two high they should be transplanted into another bed about two inches apart each way. This will make them grow stocky and form a mass of roots that will enable them to stand the final transplanting better. Celery is always best grown as a second crop on land very heavily manured for the early crop. Additions of fresh manure are apt to be harmful, though commercial fertilizers (see Appendix for formulas) high in potash may be added profitably. As they grow rankly, the tops should be sheared once or twice before the final transplanting. If the young plants are bought from the North they should be transplanted in the same way into shaded beds. The final transplanting should never be done in this latitude earlier than September 1st, and for this reason we prefer to get plants from the North, sown later than we can get them to germinate well here. Some of the Kalamazoo growers now make a specialty of growing late celery plants for southern planting, which they can do in their moist soil and cool climate better than we can. The final transplanting and growing of celery is the point in which the greatest difference comes between northern and southern culture. At the North, the growers are obliged to lift their crop in the fall and store in pits and cellars. They therefore grow it in single rows three to four feet apart, so that horse labor can be used when it is grown on a large scale. Here it is not necessary to lift the crop, and therefore we should grow it so as to earth it up most economically. The great difficulty here in some winters is to keep it from growing all winter and running to seed. We therefore plant the celery in beds, because it is more economical of labor to earth up a bed than to earth up the same number of plants in single rows, and also because the single rows, earthed up, leave the sides of the narrow banks exposed to the sun, and warm up to such an extent that the celery is kept growing when we want it to become nearly dormant. We can accomplish this better in a broad, flat-topped bed, than we can in single rows. Planted as we plant celery, an acre will contain about 37,000 plants. We set the beds five feet wide and of any convenient length, and where a number are planted a space of eight feet is left between the beds for the purpose of getting soil for earthing. The beds are never sunk, but planted upon the surface. The rows run crosswise of the beds, and are one foot apart, with eleven plants in each row, thus making them six inches apart in the row. The implements made use of in planting these beds are peculiar, and can be better undertood by means of the diagram.

THE PLANTING-BOARD.

The planting-board is used as a rapid means for keeping the rows uniform and straight, and to prevent the necessity for treading on the prepared land. It is made of an ordinary piece of one-inch plank, twelve inches wide and six feet long. The ends of this board are cut exactly square, and notched or cut on each edge, beginning six inches from each end, and six inches apart. To use the planting-board, we stretch a garden line along the edge of the proposed bed. The planting-board is then laid exactly perpendicular to this line. A plant is then set at each notch of the board The board is then moved so that the notches correspond with the plants already set, and care is taken to keep it exactly square with the line at the end. Another row of plants is set at the notches on the side of the board, and this process is repeated until the whole bed is planted. In this way the rows are kept exactly straight both ways, and the bed will be five feet wide with eleven plants in a row, and the rows one foot apart. The planter stands on the board in planting, and thus avoids disfiguring the bed with footprints.

CULTIVATION AND AFTER-TREATMENT.

After planting, the only thing necessary for some time is to keep the beds well cultivated and free from weeds.

Celery is a plant which is native to marshes and wet lands, and never reaches its best development in our hard-baking upland red clay, though fair crops can be grown in moist seasons. When a choice of locations can be had, celery should always be planted in low lands, where it is practicable to irrigate it in dry weather. Success then will be certain in almost any season. The black peaty soils and swamp lands of eastern North Carolina are as fine celery lands as can be found anywhere. The soil should be as nearly perfectly level as possible, not only to facilitate perfect irrigation, but also to prevent washing, for when a proper location is found it is best to keep the celery patch in the same place year after year, only giving attention to the fact that it must be heavily manured every year, no matter how rich it may seem. In cultivating celery, at all times it is important that the plants should never be handled while wet with dew or rain, as such handling will cause the leaves to rust and turn yellow. As the celery grows it will be found that the outer leaves will have a tendency to spread flat out upon the ground. To counteract this it will be found necessary to put it through what is called the handling process about the first of October. This is done by putting earth enough around it to hold the leaves upright, and no more than is sufficient to do this should be used, for the final earthing-up should be delayed here until November and December. Any attempt to blanch celery early in the fall in this climate will result in a hollow, rusty and inferior product. Christmas is about

as early as we should expect well bleached celery, and from that time until March we can have it as fine as anywhere, in fact, better, in our opinion.

The first handling, to put the celery in an upright position, should be made in October. We formerly used for this purpose two boards set on edge across the bed between two rows of celery and held nearly upright by pegs at each end. The earth was then thrown between the boards by two men standing on each side, who afterwards withdrew the boards so as to leave the soil in a ridge between the rows. We now do this in a simpler and better way. Provide two twine strings, twelve to fifteen feet long, with a pointed peg tied to each end. Stick a peg opposite the end of a row and about a foot away. Then take one turn of the twine around each plant in the row, so as to draw the leaves into an upright position, and finally fix the other peg into the soil opposite the other end. With the second cord and pegs treat the next row in the same way. Now shovel the fine earth from the vacant spaces on each side of the bed between the rows, and then pack it tightly by hand against the plants. Use earth enough, and no more, to hold them firmly in an erect position. Now untwine the strings and use them in the same manner on two more rows, and so proceed until all the bed is handled-up. Be sure to do this when the celery is dry, as before suggested. In the subsequent earthing, if the celery has outgrown its upright position, it may be necessary at first to use the strings again, but if the spaces between the beds are kept finely cultivated it is usually sufficient to hold the plant in the hand while an assistant shovels fine earth around it. It is important that the earth should be kept out of the heart of the plant. When the final earthing up for bleaching is begun, care must be used to build up the outside of the bed at least six inches wider than the rows are long, so that the five-foot bed will be enclosed in a bank of earth fully six feet wide. Keep adding earth as the tops elongate, and finally, about Christmas, cover entirely over with earth, and cover with straw or forest leaves to keep frost out.

As before intimated, while celery grows to a large size in the black, boggy soil of the Kalamazoo celery gardens, the best celery, so far as solidity and flavor are concerned, is grown on a moist clay loam. We have an abundance of black peaty soil in eastern North Carolina that will grow celery as large and showy as the Michigan lands, but those who have moist, loamy clay soil are very well situated, particularly if located near a stream, so that irrigation can be practiced.

Numerous varieties are named in seedsmen's catalogues, but it is well to bear in mind that the dwarf celeries so popular at the North are not so well adapted to the southern climate. Golden Heart is one of the best, and we have good reports of the Giant Paschal, but have not grown it. A good strain of the old Giant White Solid is hard to excel. Henderson's White Plume is liked by some, but we

have never found it to do well here. Sandringham is a very fine sort, intermediate between the dwarf celery and the giant.

Celery is shipped, tied in bunches of four or five stalks, packed in crates with damp moss. Celery grown here must seek its market in our own towns or southward. We cannot compete with the northern growers for the northern markets.

Egg Plant.

This crop is annually growing in importance as a vegetable for northern shipment, the demand for them having increased rapidly for years past. The egg plant is a tender tropical plant, belonging to the same natural order as the tomato and the potato. It is one of the plants that demands, for the best success in securing an early crop, that the seed be sown early in a greenhouse or hotbed, and it must be kept growing thriftily in a good uniform temperature until the weather is permanently warm outside. Any check in its growth will result in stunted plants and a worthless crop.

We always sow the seed of egg plant in shallow boxes of rich compost in a greenhouse where a night temperature of fully 65 degrees is maintained. The seeds are sown, about the middle of February, quite thickly in the boxes, and as soon as up, and even before the second pair of leaves are developed, they are carefully lifted and transplanted into other boxes of fresh soil about an inch or more apart, and set a little deeper. If left standing thickly where they germinated the "damping-off fungus" will often destroy the whole in a single night. When the rough leaves are well developed the plants are again transplanted into three-inch pots and set on the greenhouse benches. Later on they are shifted into four-inch pots in the same house. In April, when the tomato plants, that have been hardening off in the cold frames, are transplanted to the open ground, some of the egg plants should be transplanted into the frames, putting two plants under each sash. These are then to be kept protected from all chilly weather by drawing the sashes over them at night and on cool days, for the egg plant wlil not endure any chill. The remainder of the plants should be kept in the greenhouse until the soil is permanentlly warm in May.

Those set in the frames will enable the gardener to keep up a profitable use of the sashes and will be the earliest to give a crop, the sashes being removed from them when the weather is finally settled. Treated in this way the fruit can be had of marketable size in June, and any egg plants shipped during June and July will usually bring a paying price. They are marketable as soon as they attain the size of a small Jenny Lind canteloupe, or from one to three pounds weight. The fruit should never be pulled, but carefully cut with a sharp knife and packed in well-ventilated barrels, or barrel crates. It is an expensive crop to forward, but the profit depends on the earliness of the product and they will pay well for the extra expense.

The soil for egg plants should be light and warm, and as rich as it can be made. Low, wet and cold land will not make egg plants. The crop will be in exact proportion to the rapidity of their growth. Land that has been the previous year in the early Irish potato crop, and heavily fertilized, will be a suitable place for them, provided that when the potatoes are off the land it is at once sown in peas, which should be allowed to die on the land, and crimson clover seed sown among them in September. The clover and dead pea vines should be deeply plowed under in April and the surface put in good order for the egg plants.

The land should be marked off three feet each way, and a shovel full of manure, or a good handful of a high grade fertilizer (see Appendix for formulas), be well mixed with the soil at each check, ready for setting the plants in May. The after cultivation should be shallow and frequent, and a dressing of nitrate of soda during their growth will materially forward them. The Colorado potato bug is very fond of the egg plant, but in the early stages of its growth can be easily kept down by spraying with Paris green mixed with water. Later on, as the fruit forms, hand picking must be resorted to. Much work can be saved by examining the under side of the broad leaves for the orange-colored patches of the eggs of the insect, and crushing them with finger and thumb. The plants are also subject to the Southern Blight, which is so destructive to the tomato at times. This disease shows itself by the sudden wilting and death of the plants just as they are coming into fruit. The exact cause of this disease is as yet not fully determined. Some good authorities consider it the work of bacteria within the plant, while the Florida Station states that it is caused by a higher order of fungus growth, with an external mycelium. If this is the case, a spraying with Bordeaux Mixture should be effective against it. We tried this the past season on part of a plat of tomatoes at our Station, but as the disease did not make its appearance on the untreated plants, we are still uncertain as to the efficacy of the remedy. Next season we will try the same on plants set where the disease was bad the past year and repeat the treatment.

There are several varieties of egg plants, but only two of them are commonly grown. These are the New York Improved and the Black Pekin. The last named is early but not prolific and the fruit is smaller than the first, which is really the only sort worth growing. Even this rapidly deteriorates from careless saving of the seed, and while, as a rule, it seldom pays a gardener to attempt to save seed, it will always pay the southern gardener to select some of the finest fruits from some of the most prolific plants for seed. The best strain of these seed, we are acquainted with, is that largely grown among the Norfolk gardeners as Tait's Improved New York Purple.

Kale.

The Dwarf Green Curled Scotch Kale is one of the leading winter crops of the Norfolk truckers, but is not so largely grown by truckers south of the Norfolk section, because the price is apt to fall to a price that forbids any but near water transportation. In some seasons, when a severe winter destroys the crop in the North, the crop at Norfolk, and even further south, pays well. I once knew a gardener near Baltimore who sowed every vacant piece of land in the fall in kale, simply to cover the land in winter and to plow under for spring crops. In some seasons the price ruled so high that he made money by cutting the crop, but he claimed that it always paid him whether it was profitable to ship or not.

The crop is sown during August and about eight pounds of seed used per acre, so as to allow for some being eaten by the flea beetle, which is fond of them as of cabbage.

Muskmelons.

The chapter on cucumbers will apply equally well to this crop, and it is not necessary to repeat it here. The varieties in the catalogues are very numerous and new names are added annually, but the truckers still adhere mainly to the older sorts. The main variety grown by our truckers is the Jenny Lind. This is a small, green-fleshed, netted melon, well known and popular in the northern cities, and is about the earliest of any. In high quality the Emerald Gem, a green-skinned sort, with orange-colored flesh, in our opinion, stands at the head of all melons. It is, however, much later than the Jenny Lind, and is apt to crack badly in wet weather, and has not become so popular with growers, but for home use it is unsurpassed. The Hackensack and the Anne Arundel or Acme are grown to some extent for market, but more northward than in the South.

Watermelons.

The watermelon crop has of late years attained great importance in some of the southern states, not so much among the market gardeners proper as among growers on warm, thin, sandy soils that are well adapted to this crop. The extensive culture of watermelons in southern Georgia has so occupied the early market that they are not so profitable to growers in the upper South, but they can still be made to pay reasonably well on cheap lands.

The best soil for the watermelon is a high, warm, sandy soil, though good but later crops can be grown on mellow bottom lands. Land that has been newly cleared, or an old field that has been lying out for some years, are usually favorable places for the melons.

The usual method of planting, after the land has been well prepared, is to lay it off with the plow in checks ten to twelve feet each

way and plant at each intersection. The furrows are enlarged at the crossings so as to make a wide hole in which the compost is placed. The compost made of well-rotted manure and leaf mold from the woods should be prepared during the previous winter. Two or more shovelfuls should be placed in each hill, and a good handful of a high-grade fertilizer (see Appendix for formulas) should be well mixed with the surface of the hill before planting and lightly covered with soil. On the flattened surface of the hill made over the manure the seed is planted. As earliness is important, the planting should begin as soon as there is a chance for the seed to grow, making successive plantings a week apart of a few seed each time until a full stand is secured. It is well worth while to sacrifice some seed to secure the earliest stand. When a stand is secured and the plants are strong they should be thinned to two plants in each hill and the soil well loosened around those that are left. The cultivation should be rapid, before the vines get to running, by throwing furrows to the plants with a light plow. The vines should never on any account be disturbed or moved and all cultivation must be in advance of their extension.

An experienced man can easily detect a ripe melon, as soon as he looks at it, but if, on turning the melon over, the under side is yellow and blistered it is certainly ripe. A ripe melon will sound hollow on thumping in the early morning, but when they are heated in the sun a green one will sound as ripe as a ripe one. The varieties of watermelons are very numerous, but for shipping we want, above all, a melon tough enough in its rind to stand the handling to which they are subjected. No variety yet grown has become so popular among market growers as the Kolb's Gem. This is a round melon, of medium size, with a thin but tough rind and handsome, bright-red flesh. It is, however, not of fine quality or flavor and the flesh is stringy and coarse, but its carrying quality and handsome appearance make it the most profitable sort grown. The Jones melon, a recent introduction, is similar in shape to the Gem, of larger size and far better quality, but the brittle nature of its rind will forbid its use by shippers. The McIver Sugar melon, raised by Col. E. R. McIver, of Darlington, S. C., is, in our opinion, after three years' observation, by far the best watermelon in cultivation. It is an oval-shaped melon, striped light and dark green, and is the most uniform and true to type of any melon except the Kolb. In quality it is far superior to the Kolb, or any other sort we have tried except the Jones, and is fully equal to that. It promises to make a fine shipping melon and will supersede the Kolb when better known.

The same blight that attacks the tomato and egg plant attacks the watermelon, and it may be that spraying with Bordeaux Mixture will prevent it, but we cannot as yet state this definitely.

Onions.

When well grown on suitable soil there is no garden crop that promises more profit to the southern market grower than onions.

Either fer shipping bunched when half grown or as an early ripened crop they are very profitable. Formerly the impression was general in the South that onions could not be grown to full size in our climate the first season from the seed, and that it was essential to use sets of the previous year's growth for planting the crop. This is now demonstrated to be an error, for as good onions can be grown in the South the first year from the seed as can be grown anywhere, provided the seed are sown early enough. But for the early crop for bunching green in March we are satisfied that it is better to plant sets in the fall. If we could always be sure of growing weather in the early fall as good results could be had from sowing the seed in September or October. But the weather is so apt at that time to be dry and unfavorable to germination that sets are far more certain. But for a crop of ripe onions we can always produce a better crop from the seed than from sets.

Onions, like sweet potatoes, can be grown year after year on the same land, provided it is kept heavily fertilized with stable manures, but, if only commercial fertilizers are used, an occasional crop of peas turned under between crops will be needed to keep the soil supplied with the humus essential to the success of the onion crop. In the North the onion crop is largely grown on the peaty soils of reclaimed swamp lands, but for the early crop in the South we should select higher and dryer soil. A loam more inclined to sand than clay is best, and the best crops cannot be had until the land has been cultivated in the crop and well manured for several years. No crop suffers more readily from lack of cultivation than the onion. The plants will not thrive among weeds and grass, so that "Clean as an onion bed" has grown into a proverb.

We will speak first of the fall planting of sets for the green onion crop. The soil should be in the finest possible order, and furrows run as closely as will admit of mule culture. In these furrows the fertilizer is scattered, a high grade article (see Appendix for formulas), at the rate of not less than 1,000 pounds per acre. Two furrows are then lapped over the first ones, and the ridges thus made are flattened by a roller or chopped down with a hoe. On the flattened bed thus made a line should be stretched, by which a shallow mark should be made for planting. The sets are then planted by hand on this mark and just barely inserted in the soil. The bedding is important, as it puts the fertilizer just where wanted and the slight elevation above the general surface is a protection from winter rains. It also enables us to cultivate more readily with horse power among the small plants. The planting should be done in October, and little need be done, except to keep the plants clean, till cold weather sets in, and to cultivate well as soon as growth fairly begins in February. This crop should be ready to ship in March, tied in bunches of five or more, and packed in barrels, with most of the tops left on. As soon as they are off the land can be put in order for the crop of snaps, which can be followed by peas, to be cut for

hay, and prepare the soil for the next fall crop of onions. Grown in this way, the manure applied to the onions will carry the other crops, and the soil will be accumulating humus from the bean vines and the pea stubble, and no stable manure being used there will be annually fewer weeds.

THE CROP FROM SEEDS.

There are two methods of growing onions from the seed the same season. One is to sow the seed in frames in January and transplant the young plants later on. The other is to sow the seed where the plants are to grow in February. Some varieties of onions will make a much heavier crop by being sown under glass and transplanted, while with other sorts it is of no particular advantage, except in earliness. The sorts mainly benefited by this practice are the Italian and Spanish varieties. Though apparently a laborious method, it is little more so than the thinning of the crop grown in the open air. The variety best adapted to this method of culture is the large pale yellow sort known as the Prize Taker. ' This fine onion will produce superb crops when grown in this way. The seed are sown quite thickly in the frames, and when well hardened are dibbled in rows marked on heavily-manured and flattened ridges as heretofore advised for other plants.

There is no difficulty whatever in transplanting young onion plants. The same character of soil and the same fertilization advised for the fall crop will answer for this crop The only difference between this crop and that from seed direct in the open ground is that the seed are sown in this case at the time the plants would be transplanted. For most sorts we rather prefer in this climate to sow the seeds where they are to grow. If this is done as early as the ground can be worked in the spring the crop is as certain as any other vegetable. Plenty of seed should be used to secure a full stand, and they should be carefully thinned, so as to give room for full development of the bulbs. The great advantage in sowing on a slightly elevated ridge is that the crop can be easily worked by horse power, and it is easy in laying by the crop to work the soil away from the bulbs, for the onions should mature on top and not in the ground.

The mature crop of onions in the South should be shipped as soon as ripe, so as to get into the market before the northern crop does, and thereby command a better price. Few varieties grown here can be relied upon to keep well, though some will do so, and these sorts can be profitably grown for the home market, and better prices usually be had than for those that are shipped, to a limited extent.

VARIETIES.

The varieties of onions are very numerous. The earliest are the Italian sorts and the Spanish onions usually grown in Bermuda and sold as the Bermuda onion. The earliest onion of fair size is the

Queen. The ordinary stock of the Queen is by no means a large onion, but there are special strains of the Queen that attain a very good size. Tait's Extra Early Queen we have found to be a fine strain, very early and of fair size. It is a beautiful white flattish onion, but not as flat as the Bermuda. We have never been able to see any difference between this and the sort that has been of late years sold under the name of Pearl, and we believe the Pearl is only the Queen under another name. The Prize Taker is a very large globular yellow onion that has become quite popular of late. It certainly makes fine crops under good culture and is the best of all for starting under glass and transplanting. It is one of the most salable of onions and should be largely grown. It will not keep when grown South. Giant Rocca is a very large late onion of a reddish brown color. It is one of the Italian sorts, and though a big cropper we do not consider it very valuable. It is, however, a better keeper than most of the Italians. For a good cropper and a handsome globe-shaped onion, as well as the best of keepers, we have found the Southport White Globe unsurpassed. The bulbs are as sound and solid as a baseball, and they keep perfectly, even when grown in this climate. We have by no means exhausted the list of varieties, but these comprise the most valuable. The Queen will be found best for the fall crop from sets or for the earliest crop from spring-sown seeds. The Potato onion or Multiplier is always grown from fall-planted sets, as it does not make seeds. There are two varieties, the white and the yellow. The white sort is now much planted for early green bunching onions and both are used for an early ripe onion. The yellow sort is a very poor keeper and must be sold as soon as ripe; the white keeps a little better. The White Potato onion promises to be one of the very best for the eary bunching crop.

GROWING ONION SETS.

For growing sets the soil must not be so rich as for growing the onion crop and the sowing should not be so early, the object being to get as small well matured sets as possible. The seed is sown in drills in April in light, mellow soil and very thickly, not less than twenty pounds of seed per acre. As soon as ripe they are taken up and cured with the tops adhering to them and kept with the tops attached till selling or planting time. Sets of the Queen must be planted in the fall, as they will not keep for spring planting. Seed for growing sets should be home grown, or at least not grown north of Philadelphia; as the seed grown in the far North will not make good sets.

PEAS.

Early English peas are one of the most important of the crops grown by the Southern trucker. Not that they are always very profitable, but being easily and quickly grown, they help out the variety and keep labor employed in the early season. They are

so easily grown on large areas that the crop is more apt to be overdone than any other except early potatoes. The sorts grown by our gardeners are the extra early sorts and the later Marrowfats. It seems a little odd that the later peas are always sown earliest. The tall-growing Marrowfats, that need some support, are very commonly sown in large areas alongside the dead stalks in the cotton fields in November and early December, and allowed to cling for support on the dead stalks. The extra early sorts are sown on carefully prepared land in January and February.

The soil for peas should be light and warm. Land that has been well manured for a crop the previous year will need little manure to make a crop of peas, but it is a mistake to suppose that any soil is rich enough for them. They will pay as well for fair manuring as any. But no fresh stable manure should be used on the pea crop, as it induces too rank a growth of vine. A fertilizer (see Appendix for formulas) with a small percentage of nitrogen and high in potash and phosphoric acid is best for them, and 300 to 600 pounds may be used, as to the fertility of the land. While peas are generally sown for early spring sales it has become quite common and profitable of late years to sow a crop of the extra early sorts in September for shipping in November. This fall crop often pays better than the spring one.

The crop is sown in deep furrows quite thickly, so as to make a broad row, the better to sustain itself, as market gardeners seldom brush their pea vines. Rather deep covering is needed, to better enable the plants to resist the changes of the weather. Four feet apart is about the usual distance between the rows for early peas.

A good early pea for market purposes should be of a strain that makes vines of uniform development, and that ripen their crop all together: so that all can be gathered and shipped at once. There is a constant tendency in the early peas to revert to a taller and later type, and if the seed stock is not carefully "rogued" of these reversions the whole soon becomes a sad mixture. At this Station we have in past years made careful tests of many varieties. Most of the variously-named extra early peas are Daniel O'Rourke, some better rogued than others. The strains sold by Messrs. Tait, of Norfolk, Va., under the names of "Nonpareil," Eclipse" and "Hancock," we have always found to be the earliest of the class.

Irish Potatoes.

The culture of the Irish potato for the early Northern market is one of the most extensive and important crops that engage the attention of our truckers, and of late years the growing of a second crop for seed purposes has become only second in importance to the early crop, since experience has proved that the late crop of home growth is far superior, for planting the following spring, to any Northern grown potatoes. The crop of early potatoes is one in which there is

more annual fluctuation in profit than almost any other, because it is an easily grown crop, and when prices rule high for a season, the next season is sure to have a large number of the temporary truckers who are ever ready to rush into any crop that for the time promises profit, and equally ready to give up trucking in disgust when the season turns out unfavorably in receipts. This class of growers are the men who are always expecting something out of nothing, and who are unwilling to make the expenditures needed to grow first-class crops, and hence they put an inferior article on the market, and thus run down the price of all. In the present low state of prices for farm products many farmers write to us in regard to planting the potato crop for the early market who evidently do not realize the amount of labor and fertilizers that skilled truckers use, and who will probably be discouraged when told of the treatment given to this crop and others.

Early potatoes as grown in the South need more nitrogenous fertilizer than the crop does northward, where it has a longer season of growth. Growing here at an early season, when the nitrification in the soil is not so active as later, it is necessary to use a high grade fertilizer (see Appendix for formulas) in liberal amount. As much as 2,000 pounds are often used by the largest North Carolina truck farmers.

The soil for the early potato crop should be a mellow sandy loam, well supplied with vegetable matter. Land newly cleared from the forest is excellent, but the best preparation on old land is to grow a crop of peas on the land the previous season and let them die on the land to be plowed under for the crop. The plowing under should be done as soon as the vines are dead in the fall, as if plowed under just before planting they are apt to promote the scab fungus.

Planting should be done here as soon as the land can be gotten in good order after the middle of February, or even sooner, and they may be planted during the first half of March, with good prospects of success. At the North the planting is often done with a machine, but the labor conditions in our trucking sections have caused experienced growers to abandon machine-planting as more expensive than hand-planting. The general verdict here is that the machine cannot compete with the negro laborers.

Various experiments have been made to ascertain the best mode of planting potatoes, whether to cut them to single eyes, two or three eyes, or to plant whole potatoes. It has been shown that planting whole pototaes usually gives the largest crop and single eyes the smallest; but the great quantity of seed potatoes required to be kept or bought to plant them whole will always be a bar to this practice. As a rule we have found that the best results, as to profit, have been from cutting the potatoes into pieces containing two or three eyes. These are dropped into furrows two and a half to three feet apart and fifteen inches between the pieces. The fertilizer is spread along the furrows with a machine that scatters it in a broad band in the

furrow and on both side of it. It is then worked into the soil in the furrow before planting Covering is done by turning a furrow from each side over the planting furrow, so that the potatoes are surrounded by the fertilizer, and a sharp ridgé is made over the row. We leave this ridge until the potatoes are about to start, when it is harrowed down, and the soil is left in good order for the sprouting potato. We have also found that it is a saving of hand-work, as soon as the potatoes can be seen along the rows, to run a smoothing harrow crosswise the rows. This destroys the weeds and grass just starting in the hill, and gives a good working. While for the late crop we favor flat culture, the early crop in the South should, we think, be always laid by with a furrow to each side, as the ridge gets warm much quicker than the level surface.

The potato grows at a comparatively low temperature, and the warmth of early spring weather starts them into a vigorous growth to which a sudden return of frost would be fatal. When this is the case, and the potatoes are well advanced in growth, if the Weather Service predicts a coming cold wave, the plows should be started at once and a furrow plowed over the tops of the plants. This will protect them from being cut down. One of our largest growers reported last summer that the potatoes he covered just before the frost of March 26 all matured early and brought a fine price, while those he did not cover were cut down and were so late that the market was glutted when they went in.

To bring the best prices the potato crop should be ready to ship early in June. They are carefully culled in the field, and only the finest are shipped unless the price rules high enough to make it pay to ship the culls. They are shipped in barrels and covered with bagging.

SECOND CROP POTATOES.

The practice of growing a second crop of potatoes from seed of the early crop has been practiced for twenty years, but the importance of this crop to the southern gardener has only been fully realized within the past few yeàrs. Experience has demonstrated that these late grown potatoes are far better for spring planting than the northern potatoes, not only in the South but northward, and the demand for them for planting has rapidly increased, so that their production will soon form a very important item in the crops of the southern gardener.

At this Station we have made regular experiments for several years to devise the best mode of producing this crop with certainty, and have settled upon the following as the best mode of treatment. The potatoes from which it is desired to grow the second crop should be allowed to remain where they grew till perfectly ripe and the tops dead. If they are selected from the culls in digging the partly matured crop for shipping, there will be much uncertainty as to their sprouting. When the tops are dead, take them up and allow

them to remain a day or so exposed to the light until they turn greenish. Then spread them in any convenient place on the ground and cover them with pine or other straw. Sprinkle the straw and thereafter never allow it to get dry all through.

Prepare the land as for the early crop except that the fertilization need not be so heavy, and run out the rows by going twice in a furrow with a turning plow and clean out the furrow full six inches deep. As the potatoes under the straw begin to start the eyes, which will be from the first to the middle of August, plant them in the deep furrows but cover them not more than an inch over the top of the tubers until the green leaves begin to grow. Then gradually fill in the soil to them as they grow, until it is level. The after culture must be as level as possible and no hilling should be done, the object at this season of the year being to prevent the drying out of the soil. The potatoes will sprout earlier if, before bedding them under the straw, a small piece is clipped off one end and rejected. No further cutting should be done when planting. The planting should all be done by the middle of August. This crop will grow green until the frost cuts the tops down, and their immaturity prevents their sprouting before planting time, so that when they grow it is with the strong growth of the terminal bud, which gives them a great advantage over the northern potatoes, that have been long out of the ground and have had the sprouts rubbed off them in the cellar.

LATE POTATOES FOR TABLE USE.

The growing of a late crop of potatoes for table use is a different matter from growing the crop for seed purposes. For the table we want a perfectly matured product. Thefore the planting should be earlier. The seed for this crop are the potatoes of the late seed crop kept over from the previous season. These will keep over in perfect condition for the planting in July. If kept in a cool dark cellar they will seldom start their eyes until warm weather sets in. As soon as they show signs of sprouting remove them at once into full sunlight in a dry place. The sprouts will then form short, stubby and green, and will bear handling without rubbing off. They should be planted any time in July when the soil is in a good and moist condition. The planting and cultivation should be the same as for the late seed crop. This crop will be fully mature by frost and will keep well for table use. But do not attempt to keep any of these for seed, but select all seed from the regular second crop potatoes. This crop should become of immense value for the southern home market, for our markets here are still supplied with potatoes from the North at prices that would be very profitable to the home grower.

VARIETIES.

Our market growers still adhere largely to the Early Rose potato. The strain of these known as the Houlton Rose is thought to be more

productive than the old strain. Bliss' Triumph is becoming very popular in some parts of the South, and in our experiments here we are inclined to be of the opinion that it is the earliest and most productive of the early sorts. Rural New Yorker No. 2, while not classed as an early potato, will make tubers of a marketable size as early as any, though the tops are still growing green, and it is a very productive variety. Early Ohio, a potato similar in general appearance to the Early Rose but rounder, has been a popular sort in many places, and is as early and more productive than the Early Rose. The Freeman is a handsome, smooth potato of recent introduction, but we have not tested it sufficiently to be positive as to its value for the early market in the South. We regard it as very promising, and if early enough and productive enough its handsome appearance will make it a popular sort. The varieties of the potato are now so numerous that it is difficult to give an opinion of all. The Station will make further tests the coming season.

KEEPING THE IRISH POTATO IN WINTER.

It is difficult to keep the early-grown crop of potatoes in this climate. If some of the later-growing sorts, like the Rural New Yorker, Pride of the West, or Bill Nye, are planted at the usual time, they may be kept in very good condition till about Christmas, but hardly later. The late crop, grown for table use from seed kept over, will keep very well if the proper conditions are observed. These conditions are absolute darkness and a low temperature. If they could be kept constantly about 35 to 40 degrees temperature, there would be no trouble in keeping them, but it is seldom possible in this climate to maintain so low a temperature in a cellar under ground. Even if put in banks outdoors they must be taken up about the time that we usually plant potatoes or they will begin to grow, and in the cellar they will begin to sprout in the later spring. So, on the whole, the best mode practicable is to keep them as well as possible in a perfectly dark cellar, with abundant ventilation without light, whenever the outer temperature is not warmer than the cellar, and is not so intensely cold as to make it dangerous, but a temperature but little above thirty-two degrees is better far than one of fifty.

SWEET POTATOES.

The sweet potato is more a crop of the farm than the garden in the South. But this present bulletin would be hardly considered complete without some notice of this crop. There are few farmers in North Carolina who are not familiar with the cultivation of the sweet potato, and it would seem almost superfluous to attempt to give any further instructions in regard to the culture. But there is a growing disposition to grow the varieties of the sweet potato that are profitable for the northern market, and we may be able to give some hints that may be useful.

The sweet potato crop for the early market is one of the crops that will pay well to use glass in the forwarding of the plants. In order to have good strong plants at the earliest moment that it will be advisable to set them in the open ground, it is necessary to protect the plants during their earlier stages. This, of course, can be done in a measure by covering the beds with pine straw, but where one is provided, as every market gardener should be, with frames and sashes, it is far more certain and convenient to grow the plants under the sashes. In bedding the potatoes under glass no manure is needed, as we prefer to bed in pure sand. We thus avoid largely the "black shank fungus" that is often so destructive in manure-heated beds. A thick bed of sand, or very sandy soil, is placed in the frames and on this the potatoes are bedded in the usual manner and covered with an inch or more of the same. This should be done about the first of March. The sashes are at once put on and kept closed until there are signs of sprouting, when air must be given on sunny days and the bed kept regularly watered. By this means it is easy to have the plants as early as it is safe to put them out. Care must be taken, as the weather grows warmer, to expose the plants at all proper times to the full open air, so as to get them hardened off ready for the transplanting.

The sweet potato is one of the plants with which shallow plowing is far better than deep. Nearly all of our growers here make their hills too high and thus get long, crooked and unsalable potatoes in the Northern markets, where a short, chunky potato is demanded. To grow these we must have the land plowed shallow, and the ridges also shallow. The best manure is the black mold from a pine woods mixed with the pine straw and piled up the fall before in large heaps and mixed with lime. This is spread broadcast in the spring and plowed in. If then cross-plowed to mix it more perfectly all the better. Then, in running out the furrows for making the lists, we scatter in the furrow 300 pounds per acre of a mixture of 600 pounds of acid phosphate and 200 pounds of muriate of potash; make a two-furrow list over this and flatten slightly for planting. Nitrogenous manures should be avoided as tending rather to a ranker growth of tops. The woods mold and lime compost will furnish all the nitrogen needed, and the liberal percentage of potash will prevent any harm from excessive stimulation.

An ordinary cultivator is the best tool for the greater part of the cultivation, and the laying-by should be done with the ordinary tools used in the cotton crop, for the hilling generally given cotton is plenty for sweet potatoes. In setting out the plants we draw them carefully from the bed so as not to disturb the tubers and set them at once in tubs of water. They are set from these tubs dripping with water and the roots puddle themselves in the soil so that after-watering is seldom needed. These early plants are entirely for the early crop for shipping. A late crop for home use and for seed is grown by taking good sized cuttings and setting them in ridges in July and

August. Potatoes grown from these cuttings of the vines will keep far better in winter than those grown from the spring plants. Where these late potatoes are wanted only for bedding purposes a large crop of small roots can be grown by making the cuttings a yard long, coiling them around the hand and planting the whole coil, leaving only the tip exposed.

VARIETIES.

For the early crop for northern shipping, the Yellow Nansemond is largely used, but we consider the Virginia Red Nose far better. This is a plump yellow potato, with a reddish brown tip when first dug. It is more productive than the Nansemond and of better quality. For the home market and home use the White and Yellow Barbadoes, Norton Yam, and Jewell Yam are the best.

KEEPING SWEET POTATOES IN WINTER.

In this latitude, sweet potatoes that are intended for winter and spring use, should be grown from cuttings in July rather than from the spring plants. There need be no trouble in keeping sweet potatoes, if the conditions proper for their preservation are observed. The first thing essential is to get the potatoes out of the ground in the proper shape. They should not be dug when the ground is wet or the weather cold, if it can possibly be avoided. The tuberous roots of the sweet potato are very sensitive to cold and wet and should not be exposed to either. When frost cuts the vines, they should be at once cut from the hill, even if the digging cannot be done at once, for there there will at once be a fungus growth on the dead vines that will affect the roots if the vines remain attached.

Select a warm, sunny day for digging. The earth can be thrown away from each side of the rows with a plow, but we prefer to take the potatoes out by hand, as it is necessary to handle them with the utmost tenderness if they are to be expected to keep. In digging do not allow the potatoes to be thrown in piles, but let them lie scattered along the row where dug so that all will get well sunned. They can be well kept in banks outdoors if a shelter is built to exclude the rain from the banks. In hauling from the field the same care should be used in handling them that is observed in digging. Gather them up boxes or crates and never dump them into a cart body. Throw out all the bruised potatoes for immediate use, for if these are placed in the heaps they will start decay. Have ready under cover plenty of pine straw, gathered some time before in dry weather and kept dry. Put a layer not less than a foot thick on the ground where the heaps are to be made, and have the heaps in a row where no water can run under them, and where you can build a rough shed over them. Carefully pile about twenty-five bushels in a heap on the bed of straw and then cover the pile thickly

with the dry straw. When all are thus covered, put a shed over the whole and let them lie, with only the straw cover, until they go through the inevitable sweat and dry off again, and as the weather gets colder, put a good cover of earth over the whole of each pile and pack it smooth. The shed keeps the earth cover dry, and dry earth keeps out a great deal more cold than wet soil. Potatoes that are chilled will not keep. While the keeping of the Irish potato depends on a low temperature, the sweet potato needs to be kept warm.

Another and a better way can be used if one has a flue heated tobacco barn, or any building where a good temperature can be maintained by fire heat, which is to take the potatoes from the field, in the ordinary slatted shipping crates, and store them in the barn in these crates piled up so that there will be a circulation of air all through them, and none too close to the flues. Then start fires with the ventilators open and run the temperature up to about 80 degrees and keep it up until the potatoes have dried off the sweat. Then close up the house and watch it in all the changes of the weather and when the outside temperature falls, make a little fire so as not to let the barn fall below 50 degrees. If kept shut close it will seldom be necessary to have fire. Potatoes thus kiln dried at the start will keep till the next summer until the new crop comes in; but these should not be used for seed as their vitality may be injured if a higher temperature than that recommended should occur, though they will keep all the better, if dried at even a higher temperature.

Radishes.

Radishes sometimes pay very well for shipping, but as they are on hand for so short a time, we have always found it best to use them as a catch crop in the rows of early beets, to mark the rows and be pulled out before they are in the way of the beets. They are tied in bunches and shipped in ventilated barrels. The Scarlet Turnip Rooted and the Long Scarlet Short Top are the kinds used. The rose colored Chinese Winter radish is also sometimes profitably sown in the fall along with spinach and kale.

Spinach.

Spinach is very largely grown about Norfolk, Va., for winter and spring shipping to the northern markets. It is a crop very easily grown, and sometimes pays well, particularly when an extra hard winter north destroys the crop there. The seed are sown on flattened beds heavily fertilized in the furrow, and is sometimes protected with a slight ridge on the north side of the row, but usually needs no protection. The sowing is done in early September, and little cultivation is needed, as this first sowing is intended for cutting in December. The main crop, to be cut in late winter and early spring, is sown from the middle of September to the middle of October.

Spinach is only profitable on well-enriched land, and not less than 1,000 pounds of high grade fertilizer (see Appendix for formulas) should be used per acre. The entire plant is cut from the root and shipped in ventilated barrels.

TOMATOES.

To the gardener who has a good outfit of greenhouse and frames, the growing of the early crop of Tomatoes can be made one of the most profitable of all the crops of our southern gardens. With the proper treatment it should be perfectly easy for the gardener in our eastern section to put his tomatoes in the market by the first week in June, and all tomatoes shipped up to the second week in July will usually bring good prices, if a good sort and in good order. In fact, we have had ripe tomatoes in the open air in Raleigh as early as the 25th of May. To get them thus ahead of their natural season requires glass, skill, and attention, and this fact will always prevent the glutting of the markets, as is often done, with those vegetables that can be grown by anyone without these requisites.

Assuming, then, that the gardener has the necessary greenhouse, it is necessary to begin the sowing of the seed at least ten weeks before it will be safe to put the plants in the open ground. This means in our eastern section that we should sow the seed about the third week in January. For sowing the seed we use boxes or flats made usually by cutting an ordinary soap box in three flat boxes. These boxes, about three inches deep, are filled with the prepared compost recommended in potting cucumbers and melons. The seeds are sown thickly in the boxes and placed on the bench of the greenhouse close to the glass, and a night temperature of 60 degrees is maintained. As soon as the plants are well up, and before they have made the second leaves, they are transplanted to other boxes an inch or more apart, and when well established in these boxes the temperature at night is kept a little lower, say 50 to 55 degrees, and the boxes are kept as close as possible to the glass to prevent the plants from being drawn up with weak stems. The house must be well ventilated during the daytime for the same purpose. Should the plants have a tendency to run up tall the tops should be pinched out, but we prefer not to prune them at all, unless absolutely necessary. If three-inch flower-pots are at hand this first transplanting can be more profitably made by putting the plants in the pots, as experiments have proved that plants handled in pots are earlier than those handled in boxes.

By the first of March the plants should be taken from the greenhouse and planted in the cold frames about four inches apart each way. They should now have all the exposure to the outer air possible, only putting the glass over them at night and in cool, cloudy weather. The object is to get stout, short and well-hardened plants. By the first of April, or sooner, the glass can be left off at all times, and the first week in April they can be set in the open ground. It

is always best to get them out as early as practicable, even if they have to be protected from frost afterwards, which is easily done, for we have found that the earlier the plants are in the open ground and live, the earlier the crop. Last spring, as an experiment, we set out some tomato plants the 17th of March. On the 26th of March the mercury fell to 21 degrees, but we saved the plants without much trouble. Having warning from the Weather Bureau of the approach of the cold, we went to work and bent each plant to the ground and placed a wisp of straw on it, while an assistant shoveled a mound of soil over each. The plants went through the freeze unharmed and made the earliest fruit. As we seldom have, even in March, so great a degree of cold, it will be seen that it is easy to protect the plants with a shovelful of soil against any frost we may have after the first of April.

These early plants seldom suffer from the Southern Blight, which is so troublesome with the late crop here, but they are very subject to the rot. This can be warded off by the use of the Bordeaux Mixture. The plants should be sprayed, as soon as set out, with the mixture at half strength, and the spraying should be repeated as they bloom and again as the fruit swells. We have not as yet proved that this spraying will prevent blight, since our experiment last year for this purpose was not conclusive, there being no blight on the sprayed or unsprayed plants, the planting being on ground where there had been no tomatoes grown before.

It is always important to plant tomatoes here on land that has not had tomatoes, potatoes or melons on it for several years, as all of these are subject to the same blight. Tomatoes should be shipped as soon as they show signs of turning, for if allowed to get fully colored they will not arrive in good order. For the earliest it will pay to wrap in paper, as they can be thus packed more securely. The packing should be in crates with the slats nailed rather close, as wide cracks will often cause the fruit to be badly cut. Culling should be very carefully done and no cracked or damaged fruit allowed in the crate. It is easy to make a reputation for a brand of anything, and in no vegetable is this of more importance than with the tomato.

VARIETIES.

The varieties of tomatoes are innumerable, and each season new sorts are brought out with claims that they are superior to all before them. But only at rare intervals is a real improvement made. The tomato is so easily improved by careful selection, and so easily run down by careless selection, that it is hard to find a variety that long keeps its character with which it is first sent out. They are either selected into something better or allowed to degenerate into something worse. It is, therefore, one of those vegetables that the careful gardener will always select some of the best and earliest for himself and in this way improve his stock. For general purposes we have found no

variety better than the sort called Livingston's Beauty. For the earliest, the Early Ruby will always give the first fruit, but it is not of the finest quality, and as soon as the Beauty comes in it is of very little use. The grower will, of course, test many other varieties for himself and carefully select his own stock of seeds.

LATE CROP FOR CANNING.

While the canning of tomatoes can never be prosecuted as profitably in our climate, owing to climatic difficulties, as it is in New Jersey and Maryland, it may at times be desirable to plant a crop for this purpose. For this crop the seed are simply sown outdoors, as soon as the weather will allow and set in the field four by five feet, as for the early crop, and cultivated as the corn is. We have tried all the different ways of training and supporting tomatoes, and have found that the largest crop is always had by allowing the vines to take their natural course and trail on the ground. In a small garden it may be best to tie them up to economize space, but in the field it is entirely unnecessary.

TOMATOES FOR WINTER.

We have for years been trying various ways to prolong the season in which fresh tomatoes may be had after frost, and have settled on the following as the best. The plan may also be made a matter of profit for shipping, for we have had the fruit in good condition at Christmas, when the price was 25 cents per pound. About the first of July we make cuttings about a foot long from vigorous vines that have made good smooth fruit only. After a good rain these are set in well-prepared soil nearly their entire length. At this season the soil is so warm that they root with the greatest certainty, and we seldom find one that fails to grow if the soil is moist and well packed about the base of the cutting. They are set at the same distance as plants and are cultivated in the same manner. These plants will begin to ripen late in the fall, and will be full of well grown green fruit when frost arrives. When the first light frost nips the foliage the whole crop is gathered. They are wrapped in paper, packed in crates and stored in a place where they will keep cool but will not be frozen. Any tight outhouse where the crates can be covered with straw in cold weather will answer. For family use a few are taken out at a time and put in a warm room to ripen for the table. We have them in this way until the middle of January nearly every year, in nice condition for slicing. If grown in quantity for shipping they should be overhauled from time to time and the ripening ones rewrapped and shipped up to Christmas, when the whole lot can be shipped, as they will sell even if not colored, as they will soon ripen up in a warm temperature, or it may be better to bring them into a warmer place to color before shipping.

We feel sure that with a little care and experimenting this late crop can be made a source of great profit in the South.

FERTILIZERS FOR THE TOMATO CROP.

It was formerly thought that the tomato did not thrive as well with heavy manuring as most other vegetable crops, but recent experiments have shown that no plant responds more readily to heavy nitrogenous fertilization. A good shovelful of well-rotted manure to each hill is indispensable to a good crop, and if the fertilizers of a commercial character must be used they are always more effective if the planting is done on a pea fallow plowed for the crop or on a clover sod. It is also found to pay well to use about fifty pounds per acre of nitrate of soda as a top dressing around the plants during the cultivation of the crop. The early crop should always be planted on the warmest sandy land available, and in the absence of manures use not less than 1,000 pounds per acre (see Appendix for formulas) of a well-mixed high grade complete fertilizer. Few if any of the brands of mixed fertilizers have as high a percentage of potash as most truck crops require and the practice of home mixing of the fertilizer ingredients is annually becoming more common.

TURNIPS.

The only turnip crop of interest to the trucker for the northern market is the early spring crop. We have found this at times to be a very profitable one, as it is quickly grown and needs no cultivation, as the seed are sown broadcast on land that has been heavily fertilized broadcast. For this crop the lightest and warmest located land should be used, and if a piece of newly cleared land so much the better. The land is well prepared and 1,000 pounds of fertilizer (see Appendix for formulas) harrowed in, the seed are then sown evenly and thinly, and lightly brushed in with a smoothing harrow. Sow as early in February as the condition of the soil will admit. The turnips are pulled as soon as they are as large as a teacup, trimmed and shipped in barrels The whole crop should be out of the way in May. The best variety is the Extra Early Milan, which grows about as quickly as a radish. It is to be noted with this as with the late crop of turnips that a piece of light land heavily fertilized will grow a better crop than old land that has been long in cultivation and is really more fertile.

GENERAL REMARKS.

In concluding these brief directions for growing truck crops we would add that in no business does skill, careful handling and honest packing pay so well as in the growing and shipping of garden truck. Well culled products, properly packed in neat packages, always sell better than products of equally good character badly handled. Never ship culls of anything unless in an exceptionally

high market, when it will sometimes pay to ship small potatoes. Do not top any barrel or other package with better samples than are to be found all through the package, and see that all packages are full. Make a reputation for your brand. It will be money in your pocket, for the man who cheats in his packing gets a bad reputation, which depreciates the price of his products as soon as the buyers know his brand. Study the market reports and watch for the best places to ship. If you are an intelligent and studious man, and want to lead in your business, study what we have said about the use of glass, and learn to use it skilfully, for there is far more money there than in the crops that the most ignorant and least enterprising can grow. There is a great future for the skilled market gardener in North Carolina in more lines than one.

If this Bulletin will lead some to study better methods and promote the interests of the gardeners of North Carolina, its purpose will be fulfilled.

THE MIXING OF FERTILIZERS FOR TRUCKING CROPS.

By H. B. Battle, Director.

The three principal fertilizing constituents needed by growing plants are nitrogen, phosphoric acid, and potash. That these are essential in some sort of combination can easily be illustrated by an experiment where a plant is grown in pure sand, devoid of all plant food. Aided by applications containing one or more combinations of the above ingredients, the plant flourishes; without these applications the plant soon dies. The nature of the plant, and the character of soil in which it grows, determine the kind and combination of the fertilizing ingredients which are needed to make a perfect growth to maturity. In nearly all cultivated soil there is a sufficiency of the mineral ingredients required in the growth of crops other than those already mentioned, and hence it is not usually necessary to add them in the application. But as plants, in growing, continually draw upon the soil for plant-food needed by them, the supply of this food will soon become exhausted if crops are continuously taken from the land, unless adequate returns are made to the soil to supply the deficiency. This condition is being reached in nearly all cultivated fields, and in order to secure profitable returns from the growing of any crop, plant-food must be furnished by artificial applications. This is notably the case with trucking crops upon soils and locations suitable to them. In order to reach an early maturity, as well as to secure large yields, heavy applications of fertilizers are needed.

Fertilizers to be applied to the soil for such crops can be purchased already mixed, or the materials may be bought and mixed at home. By care, this mixing can be done well and at small cost (at the outside limit of fifty cents per ton). Another advantage is that the proportions can be altered to suit the special requirements of each crop and the soil upon which it is to be grown. The ingredients can also be selected for specific objects and bought on a guarantee as to grade. These advantages do not exist in the case of the ready-mixed fertilizers.

Needs of Certain Trucking Crops.

The crops named below contain the several constituents as noted in the proportion determined by analysis. The average crop is also given, and the total amount of the ingredients—nitrogen (equivalent to ammonia), available phosphoric acid, and potash—contained in the average crop This is interesting as giving the quantity of these ingredients removed from the soil by the crops stated. The average yield of the various crops per acre is stated, but will vary very materially under different conditions. With the constituents contained in 1,000 pounds of each crop, as given in Table 1, it is easy to calculate the total fertilizing ingredients removed from the soil by any given crop as marketed (Table 2). These figures do not include vines or roots where not marketed.

TABLE 1.—Average Weight of Fertilizing Constituents in 1,000 Pounds of Trucking Crops.

MARKETABLE CROP.	ONE THOUSAND POUNDS CONTAIN			
	Nitrogen.	Equivalent to Ammonia.	Available Phos. Acid.	Potash.
	lbs.	lbs.	lbs.	lbs.
Asparagus	2.9	3.52	0.8	2.9
Beets	2.4	2.91	0.9	4.4
Cabbages	3.8	4.61	1.1	4.3
Cauliflower	1.3	1.58	1.6	3.6
Cucumbers	1.6	1.94	1.2	2.4
Lettuce	2.3	2.79	0.7	3.7
Onions	1.4	1.70	0.4	1.0
Potatoes, Irish	2.1	2.55	0.7	2.9
Tomatoes	1.6	1.94	0.5	2.7
Turnips	1.8	2.19	1.0	3.9
Compare with				
Wheat (grain)	23.6	28.7	8.90	6.10
Corn (grain)	18.2	22.1	7.00	4.00

The weight of fertilizing constituents of the marketed crop is stated in the following table. The average yield and weight per bushel or package are subject to correction:

TABLE 2.—Average Yield* of Trucking Crops, and the Weight of the Fertilizing Constituents Contained in them.

CROP.	MARKETABLE PRODUCT.	Total W'ght	CONTAINING			
			Nitrogen.	or Ammonia.	Avail. Phos. Acid.	Potash.
		lbs.	lbs.	lbs.	lbs.	lbs.
Asparagus	------------------------------	4.000	11.6	14.08	3.2	11.6
Beans, Lima	30 bushels, dry, at 60 lbs	1.800	------	--------	------	------
Beans, Snap	150 crates at 40 lbs	6,000	------	--------	------	------
Beets (Early)	100 barrels at 180 lbs	18,000	43.2	52.38	16.2	79.2
Cabbage, "	200 barrels at 150 lbs	30,000	114.0	138.30	33.0	129.0
Cauliflower	1,000 heads at 4 lbs	4 000	5.2	6.32	6.4	14.4
Cucumbers	1,000 bushels at 70 lbs	70,000	112.0	135.80	84.0	168.0
Celery	3,000 heads at 2 lbs	6,000	------	--------	------	------
Egg Plant	130 barrels at 200 lbs	26,000	------	--------	------	------
Lettuce	40,000 heads at ¾ lb	30 000	69.0	83.70	21.0	111.0
Melons, Musk	5,000 at 2 lbs	10.000	------		------	------
Onions	800 bushels at 60 lbs	48.000	67.2	81.60	19.2	48.0
Peas (Green)	175 1-bushel crates at 50 lbs	8.750	------	--------	------	------
Potatoes, Irish	80 barrels at 175 lbs	14,000	29.4	35.70	9.8	40.6
" Sweet	300 bushels at 60 lbs	18,000	------	--------	------	------
Tomatoes	100 bushels at 70 lbs	7 000	11.2	13.58	3.5	18.9
Spinach	100 barrels at 60 lbs	6.000	------	--------	------	------
Turnips	500 bushels at 65 lbs	32 500	58.5	71.18	32.5	126.8
Compare with						
Wheat (grain)	15 bushels at 60 lbs	900	21.2	25.83	8.01	5.5
Corn (grain)	20 bushels at 56 lbs	1.120	20.4	24.75	7.8	4.5

*Subject to correction.

Ingredients Used in Mixing Fertilizers.

To supply the necessary fertilizing constituents withdrawn by the crops, recourse must be had to artificial applications. These can be secured from three sources, animal, vegetable, and mineral. The nitrogen (or ammonia) is derived in the main from animal sources, though cotton-seed meal, a valuable ingredient, yielding nitrogen, is derived from a vegetable source. Nitrate of soda is more nearly from a mineral source than any other. Potash is derived from a mineral source, though tobacco stems and wood ashes and cotton-seed hull ashes are derived from vegetable sources. The phosphates are mainly for animal sources, such as bone, and the fossil phosphates also can be considered originally formed from animal remains.

The special object of nitrogenous fertilizers is to promote growth of the plant. While phosphoric acid and potash are needed to assist in this growth, they are particularly serviceable in the formation of the seed or fruit of the plant.

TABLE 3.—Average Percentage Composition of Fertilizing Ingredients.

INGREDIENTS.	CONTAINING			
	Nitrogen	or Ammonia.	Phosphoric Acid.	Potash.
Furnishing Nitrogen Principally.				
Sulphate of Ammonia, 98 per cent	20	24	----	----
Nitrate of Soda, 97 per cent.	16	19	----	----
Dried Blood	13	16	5	----
Fish Scrap	8.2	10	8.†	----
Tankage	7.4	9	11.††	----
Azotin	12.3	15	7.	----
Cotton-seed Meal	7	8.50	2.5*	1.8
Furnishing Potash Principally.				
Kainit	----	----	----	12.5
Sylvinit	----	----	----	17.
Sulphate of Potash, High Grade (96 per cent.)	----	----	----	52.
Sulphate of Potash, Low Grade (Double Manure Salt)	----	----	----	27.
Muriate of Potash, High Grade (90 to 95 per cent	----	----	----	57.
Muriate of Potash, Sec'd Grade (80 to 85 per cent	----	----	----	52.
Muriate of Potash, Third Grade (70 to 75 per cent	----	----	----	46.
Wood Ashes (Hard Wood Unleached)	----	----	2.	8.
Cotton seed Hull Ashes	----	----	9.	23.
Tobacco Stems	1.5	1.80	.75	5.
Furnishing Phosphoric Acid Principally.				
Acid Phosphate	----	----	10–14*	----
Dissolved Bone	----	----	14*	----
Bone Meal	----	----	23	----
Bone Black	----	----	28	----
Bone Ash	----	----	35	----
Dissolved Bone Black			16*	

* Available Phosphoric Acid. † Contains 4 per cent. Available Phosphoric Acid. †† Contains 4 per cent. Available Phosphoric Acid.

In the foregoing table (3) is given a list of the principal fertilizing ingredients, with the average composition of each. As a rule separate ingredients are selected to supply the different constituents needed, though in some cases (cotton-seed meal, tankage, blood, etc.), besides the principal constituent contained, they have a small percentage of the remaining two constituents.

Average Cost of Fertilizing Ingredients.

The list below gives the average market quotations at the present time (January, 1895), of the various ordinary fertilizing ingredient. The quotations are based on the cash price in small lots in bags for five tons and less *f. o. b.* at the seaboard. The quotations are liable to fluctuation. Freight rates to interior towns must be added to ascertain the cost at the latter places.

TABLE 4.—Seaboard Prices of Fertilizing Ingredients.

[For interior points add freight.]

Sulphate of Ammonia	$80.00	per ton.
Nitrate of Soda	50.	"
Dried Blood	50.	"
Fish Scrap	27.50	"
Cotton-seed Meal	20.	"
Tankage	25.	"
Kainit	11.50	"
Sylvinit	16.	"
Sulphate of Potash (High Grade)	45.	"
Sulphate of Potash (Low Grade)	30.	"
Muriate of Potash, 52 per cent.	45.	"
Acid Phosphate, 14 per cent	12.	"
Acid Phosphate, 13 per cent	11.50	"
Acid Phosphate, 11 per cent	10.	"
Bone Meal	28.	"
Dissolved Bone Black	23.	"

Special Mixtures for Special Crops.

As the nature of plants vary, so does the power possessed by them of drawing upon the plant-food in the soil. It has been ascertained also that different crops respond better to the use of particular mixtures of fertilizing ingredients. Quick-growing annuals, such as vegetables, are especially benefited by special mixtures, and usually the larger the amount applied the better will be crop yield. The different vegetables require different combinations of foods, and the proportions of each ingredient is further modified by the character of the soil, the climatic and weather conditions during the growing season.

The following table (5) is presented, giving the percentages of the three valuable ingredients (ammonia, available phosphoric acid, and potash) which should be present in fertilizing applications for the several trucking crops named. The table is given tentatively as being the result of such observations and experiences as are available. Necessarily the proportions are susceptible to modification to

suit particular localities as determined by individual experiences. It is believed that these proportions, or near them, will suit the trucking lands of eastern North Carolina more generally than any others that could be stated. The sandy lands of this section are deficient in potash, and the proportions of the constituents take account of this fact.

More correctly, the nitrogenous ingredients should be stated entirely in terms of the nitrogen content, but usage has to a great extent regulated the term to be used, which is generally accepted as *ammonia*. Both are accordingly given in the table, but in the calculation of the formulas, only the ammonia (and not its equivalent in nitrogen) is used.

TABLE 5.—Average Percentages of Constituents for Fertilizers for Trucking Crops.

	Ammonia.	*Containing Nitrogen.*	*Available Phos. Acid.*	*Potash.*
1. Asparagus	5	4.12	6	8
2. Beans, Lima	3	2.47	7	7
3. Beans, Snap	3	2.47	7	7
4. Beets	6	4.94	5	8
5. Cabbages	6	4.94	5	7
6. Cauliflower	6	4.94	5	7
7. Cucumber	6	4.94	5	7
8. Celery	7	5.77	5	8
9. Egg Plant	5	4.12	6	7
10. Lettuce	6	4.94	5	8
11. Melons, Musk	6	4.94	5	7
12. Melons, Water*	6	4.94	5	7
13. Onions	5	4.12	5	8
14. Peas	3	2.47	7	7
15. Potatoes, Irish	6	4.94	7	8
16. Potatoes, Sweet	3	2.47	7	8
17. Radishes	5	4.12	7	8
18. Tomatoes	5	4.12	6	7
19. Spinach	5	4.12	8	6
20. Turnips	5	4.12	7	8

How to Calculate the Proportions of a Fertilizer to Yield Definite Percentages.

The percentages of the constituents—ammonia, phosphoric acid, and potash—refer to so many parts per 100. For example, 5 per cent. of ammonia represents 5 pounds of ammonia in 100 pounds of the fertilizer, or, calculated to the ton, would represent 100 pounds per ton of 2,000 pounds. In the same way, 6 per cent. of available phosphoric acid represents 6 pounds in the 100, or 120 in the ton. Eight per cent. of potash represents 8 pounds per 100, or 160 pounds per ton. Consequently, with these percentages, a ton of the fertilizer would contain 100 pounds of ammonia, 120 pounds of available phosphoric acid, and 160 pounds of potash. To prepare a fertilizer of such percentages, it must contain the number of pounds to the ton (2,000 pounds) as just stated.

*Fertilizer for muskmelons is suggested for watermelons.

The following may be given as an example, the grade of the ingredients in percentages used being determined by reference to the previous table:

Ingredients Taken, Containing	*Ammonia.* *lbs.*	*Available Phos. Acid.* *lbs.*	*Potash.* *lbs.*
Cotton-seed Meal, 700 lbs	59.5	17.5	11.6
Nitrate of Soda, 200 lbs	38	-----	-----
Sulphate of Potash, high grade, 300 pounds	----	-----	156.
Acid Phosphate, 13 pr. ct., 800 lbs.	----	104.	-----
Total 2,000 lbs. containing	97.5	121.5	167.6
Divided by 20 to reduce to 100 lbs	4.87	6.07	8.38
Equivalent to percentages	4.87 pr. ct.	6.07 pr. ct.	8.38 pr. ct.

If it be desirable to have the exact percentages of 5, 6, and 8, respectively, instead of 4.87, 6.07, and 8.38, as calculated, it can easily be done by reducing the amount of sulphate of potash and increasing the amount of cotton-seed meal or nitrate of soda, whichever is desired. But, in practice, it is hardly necessary to reach the *exact* percentages suggested in the tables for different fertilizers, and an approximation as close as the above calculation is sufficient.

Another example may be chosen. Suppose a fertilizer is desired containing 3 per cent. of ammonia, 7 per cent. of available phosphoric acid and 7 per cent. of potash. It can be secured as follows:

Ingredients Taken, Containing	*Ammonia.* *lbs.*	*Available Phos. Acid.* *lbs.*	*Potash.* *lbs.*
Fish Scrap, 400 lbs	40	12.	-----
Nitrate of Soda, 100 lbs	19	-----	-----
Muriate of Potash, 50 pr. ct., 320 lbs	----	-----	160.
Acid Phosphate, 11 pr. ct., 1,180 lbs	----	129.8	-----
Total 2,000 lbs	59.	141.8	160.
Divided by 20 to reduce to 100 lbs.	2.95	7.09	8.00
Equivalent to Percentages	2.95 pr. ct.	7.09 pr. ct.	8.00 pr. ct.

Total Cost of the Ingredients in Mixed Fertilizers.

It is easy to calculate the cost of the ingredients composing the mixture after the proportions have been determined. By referring to the previous table (1), the average prices of the ingredients at the seaboard are readily seen Freight charges should be added to ascertain the cost at interior towns. For convenience of calculation, the following table of freight rates is inserted. If less than ten tons are ordered, the rates must be increased by 20 per cent., or one-fifth:

FREIGHT RATES FROM THE SEABOARD TO INTERIOR POINTS.

CORRECTED TO JANUARY 16, 1895, FROM THE PUBLISHED RATES OF THE ASSOCIATED RAILWAYS OF VIRGINIA AND THE CAROLINAS.

In Car loads, of not less than 10 tons each, per ton of 2,000 pounds. Less than Car load, add 20 per cent.

DESTINATION.	From Wilmington, N. C.	From Norfolk and Portsmouth, Va.	From Charleston, S. C.	From Richmond, Va.	DESTINATION.	From Wilmington, N. C.	From Norfolk and Portsmouth, Va.	From Charleston, S. C.	From Richmond, Va.
Advance	$ 3 90	$ 4 10	$ 4 70	$ 3 50	Maxton	$ 2 20	$3 80	$3 50	$ 3 80
Apex	2 70	3 00	4 20	3 00	Mebane	3 00	3 60	4 20	3 00
Asheboro	3 60	3 80	4 25	3 20	Milton	3 50	2 40	4 50	2 30
Asheville	4 00	4 60	4 60	4 00	Mocksville	3 90	4 10	4 70	3 50
Chapel Hill	3 20	3 80	4 40	3 20	Monroe	3 00	3 20	3 20	3 20
Charlotte	3 00	3 20	3 20	3 20	Morven	2 70	3 85	2 70	3 85
Clayton	2 70	3 60	4 20	3 00	Mount Airy	3 20	3 50	4 20	3 50
Cherryville	3 30	3 60	3 40	3 60	Nashville	2 40	3 00	3 40	3 00
Clinton	2 05	3 20	3 40	3 20	Newbern	1 75	3 30	3 95	3 30
Creedmore	3 30	3 00	4 30	3 00	Norwood	3 50	3 80	4 20	3 20
Cunningham	3 50	——	——	2 40	Oxford	3 50	3 60	4 50	3 00
Dallas	3 40	3 60	3 40	3 50	Pineville	3 20	3 95	3 20	3 45
Davidson College	3 90	4 50	4 15	3 90	Pittsboro	2 70	3 30	4 40	3 30
Dudley	2 05	3 20	3 40	3 20	Polkton	2 75	3 20	3 20	3 20
Dunn	2 40	3 00	3 40	3 00	Raleigh	2 70	3 00	4 20	3 00
Durham	3 00	3 00	4 20	3 00	Reidsville	3 75	3 00	4 50	2 40
Elkin	3 60	3 80	4 40	3 20	Rockingham	2 70	3 20	4 00	3 20
Elm City	2 40	2 90	3 40	2 90	Rocky Mount	2 40	2 90	3 40	2 90
Fair Bluff	2 10	3 80	2 70	3 80	Ruffin	3 75	2 80	4 50	2 20
Fayetteville	1 60	3 00	3 00	3 00	Rural Hall	3 20	3 20	4 40	3 20
Forestville	3 30	3 00	4 30	3 00	Rutherfordton	3 40	3 65	3 40	3 65
Gastonia	3 40	3 60	3 40	3 50	Salisbury	3 50	3 80	4 20	3 20
Gibson's	2 70	4 00	2 70	4 00	Sanford	2 20	3 00	3 80	3 00
Goldsboro	2 10	3 00	3 40	3 00	Selma	2 40	3 00	3 40	3 00
Greensboro	3 00	3 00	3 80	3 00	Shelby	3 40	3 60	3 40	3 60
Hamlet	2 70	3 20	3 60	3 20	Siler City	2 40	3 60	3 80	3 60
Henderson	3 30	3 00	4 30	3 00	Smithfield	2 40	3 00	3 40	3 00
Hickory	4 00	4 00	4 25	4 00	Spring Hope	2 45	3 00	3 45	3 00
High Point	3 40	3 80	4 20	3 20	Statesville	3 20	3 80	4 00	3 20
Hillsboro	3 00	3 60	4 20	3 00	Stem	3 50	3 60	4 50	3 00
Kernersville	3 40	3 60	4 20	3 00	Tarboro	2 00	2 00	3 40	2 50
Kinston	2 20	2 50	3 50	2 50	Waco	3 30	3 60	3 40	3 60
LaGrange	2 10	3 20	3 65	3 20	Wadesboro	2 70	3 20	2 70	3 20
Laurel Hill	2 60	3 80	4 00	3 80	Walnut Cove	3 00	3 00	4 20	3 00
Luarinburg	2 30	3 80	4 00	3 80	Warrenton	3 55	3 25	4 55	3 25
Liberty	2 50	3 60	3 80	3 60	Warsaw	2 00	3 20	3 40	3 20
Louisburg	3 30	3 00	4 30	3 00	Washington	1 75	1 50	3 00	1 50
Lumberton	2 20	3 80	3 70	3 80	Weldon	2 45	2 00	3 85	2 00
Macon	3 30	3 00	4 30	3 00	Wilson	2 40	2 90	3 40	2 90
Madison	3 00	3 00	4 20	3 00	Winston-Salem	3 00	3 00	4 20	3 00
Matthews	3 00	3 20	3 20	3 20					

Suppose, now, it is desired to ascertain the average cost at the seaboard of the ingredients in the first of the two formulas just given. It can be done as follows:

Cotton-seed Meal, at $20 per ton	700 lbs. =	$ 7.00
Nitrate of Soda, at $50 per ton	200 lbs. =	5.00
Sulphate of Potash, at $45 per ton	300 lbs. =	6.75
Acid Phosphate, at $11.50 per ton	800 lbs. =	4.60
Cost of ingredients at the seaboard per ton of	2,000 lbs. =	$23.35

Or, if it is desired to ascertain the cost of the ingredients at an interior town—for example, at Kinston—on the basis of quotations

obtained at Wilmington, at the prices mentioned below, it can be be done as follows, considering the second of the two formulas given above, and adding $2.64 per ton (20 per cent. being added to ton rates for less than carload) from Wilmington to Kinston:

Fish Scrap	at $27.50 per ton at Wilmington, and	$30.14 at Kinston,	400 lbs. =	$ 6.03
Nitrate of Soda	at 50.00 " " "	52.64 "	100 lbs. =	2.63
Muriate of Potash	at 45.00 " " "	47.64 "	320 lbs. =	7.62
Acid Phosphate	at 11.00 " " "	13.64 "	1,180 lbs. =	8.04
Cost of the ingredients at Kinston per ton of			2,000 lbs. =	$24.32

Mixing the Ingredients.

The ingredients should be in good mechanical condition—fine and dry. In this state they can easily be mixed to close uniformity. If any lumps occur they can be mashed before endeavoring to mix the materials. A clean floor should be used, or, if this cannot be had, mix upon hard compact soil. Materials sufficient to make a fourth or half a ton should be carefully weighed out and poured on the floor in alternate layers; then, with hoes on opposite sides of the mixture, the materials should be mixed to a uniform color throughout. If the different materials cannot be detected, and the color is the same in all parts of the pile, we can be reasonably sure that a good mixture has been effected. After gaining experience, a larger quantity than half-ton can be taken for the mixing. An empty wagon-body will be found useful in which to mix a small quantity. After mixing, the fertilizer can be returned to the original bags, and, if desired, can be used at once. It is not desired to store such mixtures for a long time, especially if nitrate of soda has been used as one of the ingredients. In such a case the tendency is for the acid phosphate to cause some decomposition and loss of nitrogen. The nitrate of soda easily absorbs moisture from the air, and on this account also it is not desirable to keep it in store.

Special Formulas Suggested for Trucking Crops.

The fertilizing ingredients to be used in compounding any special fertilizer of a particular percentage will depend upon the materials which can be conveniently secured, as well as their cost. For trucking crops these ingredients should be readily soluble and in a form needed by the plants to produce rapid and effective growth. Earliness, above nearly all else, is to be desired, so that the crops can be marketed at a time when remunerative prices can be secured. In the formulas suggested below, the nitrogen (or ammonia) is furnished by the easily soluble and quickly available nitrate soda, in conjunction with a nitrogenous ingredient such as cotton-seed meal, fish scrap, tankage, etc., that becomes available to plants during the various stages of growth. Oftentimes it is advisable to reserve a portion of the nitrate soda from the first application to be worked in around the plants after they have reached a portion of their growth. The potash and

phosphoric acid ingredients are not so liable to become leached out of the soil or carried beyond the reach of the roots.

In the formulas calculated below, ingredients are mainly used that are easily procurable and of relatively small cost. The percentages are based upon those already given in Table 5, but are not strictly adhered to. Where variations occur, the relative proportions of the stated percentages are maintained, and choice can be taken in reference to cost and ease of procuring the materials.

It is expected that changes will be made in the proportions suggested, to be governed by the character of the soil of any particular locality, or by any results secured from previous applications and experiences. Each trucker must be his own judge in such matters. The formulas are presented as being the best starting points for actual practice, to be amended or altered as further experience would dictate. By the explanations previously given, it will not be a difficult matter for anyone to calculate other combinations than those suggested. The amounts for applications per acre have already been stated in the body of this bulletin.

SPECIAL FORMULAS PROPOSED.

A. For Celery: 7 per cent. Ammonia, 5 per cent. Available Phosphoric acid, 8 per cent Potash.

1.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield	6.9 pr. ct. Ammonia.
	800 "	Fish scrap, seaboard cost	11.00		5.5 " Avail. phos. acid.
	600 "	Acid phos., 13 pr. ct., seaboard cost	3.45		8.0 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,006 "	Total seaboard cost, unmixed	$28.70		

2.	250 lbs.	Nitrate soda, seaboard cost	$ 6.25	will yield	7.2 pr. ct. Ammonia.
	600 "	Dried blood, seaboard cost	15.00		5.5 " Avail. phos. acid.
	850 "	Acid phos., 13 pr. ct., seaboard cost	4.89		7.8 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$32.89		

B. For Irish Potatoes: 6 per cent. Ammonia, 7 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield	5.4 pr. ct. Ammonia.
	600 "	Cotton seed meal, seaboard cost	6.00		7.2 " Avail. phos. acid.
	800 "	Dissolved bone black, seaboard cost	9.20		8.1 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$29.45		

2.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield	5.8 pr. ct. Ammonia.
	600 "	Fish scrap, seaboard cost	8.25		6.8 " Avail. phos. acid.
	800 "	Acid phos., 14 pr. ct., seaboard cost	4.80		7.8 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$27.30		

3.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield	6.4 pr. ct. Ammonia.
	900 "	Fish scrap, seaboard cost	12.38		6.6 " Avail. phos. acid.
	600 "	Dissolved bone black, seaboard cost	6.90		7.8 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$31.03		

4.	220 lbs.	Nitrate soda, seaboard cost	$ 5.50	will yield 6.1 pr. ct. Ammonia.
	500 "	Dried blood, seaboard cost	12.50	6.8 " Avail. phos. acid.
	970 "	Acid phos., 14 pr. ct., seaboard cost	5.82	8.0 " Potash.
	310 "	Muriate potash, seaboard cost	6.93	
	2,000 "	Total seaboard cost, unmixed	$30.75	

5.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield 5.4 pr. ct. Ammonia.
	600 "	Cotton-seed meal, seaboard cost	6.00	6.0 " Avail. phos. acid.
	800 "	Acid phos., 13 pr. ct., seaboard cost	4.60	8.3 " Potash.
	300 "	Muriate potash, seaboard cost	6.75	
	2,000 "	Total seaboard cost, unmixed	$24.85	

6.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield 5.5 pr. ct. Ammonia.
	600 "	Tankage, seaboard cost	7.50	6.4 " Avail. phos. acid.
	800 "	Acid phos., 13 pr. ct., seaboard cost	4.60	7.8 " Potash.
	300 "	Sulphate potash, H. G., seab'd cost	6.75	
	2,000 "	Total seaboard cost, unmixed	$26.53	

C. For Beets and Lettuce: 6 per cent. Ammonia, 5 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield 6.2 pr. ct. Ammonia.
	800 "	Cotton-seed meal, seaboard cost	8.00	4.9 " Avail. phos. acid.
	600 "	Acid phos., 13 pr. ct., seaboard cost	3.45	8.5 " Potash.
	300 "	Muriate potash, seaboard cost	6.75	
	2,000 "	Total seaboard cost, unmixed	$25.70	

2.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield 5.9 pr. ct. Ammonia.
	800 "	Fish scrap, seaboard cost	11.00	5.4 " Avail. phos. acid.
	700 "	Acid phos., 11 pr. ct., seaboard cost	3.50	7.8 " Potash.
	300 "	Muriate potash, seaboard cost	6.75	
	2,000 "	Total seaboard cost, unmixed	$26.25	

D. For Cabbage, Cauliflower, Cucumbers, and Melons: 6 per cent. Ammonia, 5 per cent. Available Phosphoric Acid, 7 per cent. Potash.

1.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield 6.0 pr. ct. Ammonia.
	750 "	Cotton-seed meal, seaboard cost	7.50	4.8 " Avail. phos. acid.
	700 "	Acid phos., 11 pr. ct., seaboard cost	3.50	7.1 " Potash.
	250 "	Muriate potash, seaboard cost	5.63	
	2,000 "	Total seaboard cost, unmixed	$24.13	

E. For Spinach: 5 per cent. Ammonia, 8 per cent. Available Phosphoric Acid, 6 per cent. Potash.

1.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield 5.2 pr. ct. Ammonia.
	650 "	Fish scrap, seaboard cost	8.94	7.7 " Avail. phos. acid.
	920 "	Acid phos., 14 pr. ct., seaboard cost	5.52	6.0 " Potash.
	230 "	Muriate potash, seaboard cost	5.18	
	2,000 "	Total seaboard cost, unmixed	$24.64	

2.	300 lbs.	Nitrate soda, seaboard cost	$ 7.50	will yield 5.0 pr. ct. Ammonia.
	500 "	Cotton-seed meal, seaboard cost	5.00	7.6 " Avail. phos. acid.
	1,000 "	Acid phos., 14 pr. ct., seaboard cost	6.00	5.6 " Potash.
	200 "	Muriate potash, seaboard cost	4.50	
	2,000 "	Total seaboard cost, unmixed	$23.00	

F. For Radishes and Turnips: 5 per cent. Ammonia, 7 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	250 lbs.	Nitrate soda, seaboard cost	$ 6.25	will yield	4.6 pr. ct. Ammonia.
	550 "	Cotton-seed meal, seaboard cost	5.50		6.5 " Avail. phos. acid.
	900 "	Acid phos., 13 pr. ct., seaboard cost	5.18		8.3 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$23.68		

G. For Asparagus: 5 per cent. Ammonia, 7 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield	4.9 pr. ct. Ammonia.
	700 "	Cotton-seed meal, seaboard cost	7.00		6.1 " Avail. phos. acid.
	800 "	Acid phos., 13 pr. ct., seaboard cost	4.60		8.4 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$23.35		

H. For Egg Plant and Tomatoes: 5 per cent. Ammonia, 6 per cent. Available Phosphoric Acid, 7 per cent. Potash.

1.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield	4.9 pr. ct. Ammonia.
	700 "	Cotton-seed meal, seaboard cost	7.00		6.3 " Avail. phos. acid.
	840 "	Acid phos., 13 pr. ct., seaboard cost	4.83		7.4 " Potash.
	260 "	Muriate potash, seaboard cost	5.85		
	2,000 "	Total seaboard cost, unmixed	$22.68		

I. For Onions: 5 per cent. Ammonia, 5 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	200 lbs.	Nitrate soda, seaboard cost	$ 5.00	will yield	5.1 pr. ct. Ammonia.
	750 "	Cotton-seed meal, seaboard cost	7.50		5.1 " Avail. phos. acid.
	750 "	Acid phos., 11 pr. ct., seaboard cost	3.75		8.5 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$23.00		

J. For Sweet Potatoes: 3 per cent. Ammonia, 7 per cent. Available Phosphoric Acid, 8 per cent. Potash.

1.	100 lbs.	Nitrate soda, seaboard cost	$ 2.50	will yield	3.5 pr. ct. Ammonia.
	400 "	Fish scrap, seaboard cost	5.50		7.8 " Avail. phos. acid.
	1,180 "	Acid phos., 11 pr. ct., seaboard cost	5.90		8.3 " Potash.
	320 "	Muriate potash, seaboard cost	7.20		
	2,000 "	Total seaboard cost, unmixed	$21.10		

2.	100 lbs.	Nitrate soda, seaboard cost	$ 2.50	will yield	3.5 pr. ct. Ammonia.
	500 "	Cotton-seed meal, seaboard cost	5.00		7.8 " Avail. phos. acid.
	1,100 "	Acid phos., 13 pr. ct., seaboard cost	6.33		8.3 " Potash.
	300 "	Muriate potash, seaboard cost	6.75		
	2,000 "	Total seaboard cost, unmixed	$20.58		

K. For Beans and Peas: 3 per cent. Ammonia, 7 per cent. Available Phosphoric Acid, 7 per cent. Potash.

1.	100 lbs.	Nitrate soda, seaboard cost	$ 2.50	will yield	2.9 pr. ct. Ammonia.
	450 "	Cotton-seed meal, seaboard cost	4.50		7.1 " Avail. phos. acid.
	1,200 "	Acid phos., 11 pr. ct., seaboard cost	6.00		6.9 " Potash.
	250 "	Muriate potash, seaboard cost	5.63		
	2,000 "	Total seaboard cost, unmixed	$18.63		

The Testing of Milk

I. THE BABCOCK MILK TEST.
II. THE DETECTION OF ADULTERATIONS IN MILK.
III. BUYING AND SELLING COWS BY TESTS OF THEIR MILK.
IV. THE PRACTICAL VALUE OF MILK TESTING.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

BULLETIN No. 113.

JUNE 15, 1895

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

RALEIGH, N. C.

PREFACE.

The present is another of the series of bulletins issued by the Experiment Station to lend encouragement to the dairy interests of the State. The result of experience shows that a more lasting prosperity comes from the plan of raising improved breeds of stock and by dairying than by any one-crop system of farming. In order to aid in this undertaking the present bulletin by Prof. F. E. Emery, Agriculturist of the Station, is issued.

The complete bulletin, the table of contents of which may be seen on the following pages, will be sent to any person in North Carolina who receives this preliminary notice, and who will make application to the undersigned.

H. B. BATTLE, *Director.*

CONTENTS.

The complete bulletin embraces 32 pages. It will be sent free on application to parties inside North Carolina; to others, on receipt of four cents in postage. Apply to Dr. H. B. BATTLE, Director, Raleigh, N. C.

THE TESTING OF MILK.

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By F. E. Emery, Agriculturist.

I. THE BABCOCK MILK TEST.

This test was the first of a number of plans which have been proposed within the past few years, in response to a demand in dairy regions for an accurate, cheap, and comparatively rapid means for determining the amount of fat in milk.

A number of methods are accurate, but they do not combine rapidity with cheapness, or show sufficient simplicity in manipulation to meet the every-day needs of farms and creameries.

In introducing this test, Dr. S. M. Babcock, of the Wisconsin Experiment Station, has more nearly met the demand of the age than anyone else, and this test has become famous all around the world. It has been so often described that any new attempt in this line may seem superfluous. The basis is the comparison of the weight of a given volume of milk at the average specific gravity of 1.032 with the weight of the volume of fat contained in it when raised to a temperature of about 120°F., at which the fat is a liquid and its specific gravity is 0.90. The addition of commercial sulphuric acid dissolves the casein of the milk and sets free the fat and ash. The acid increases the specific gravity of the fluid and widens the difference in specific gravity between the fat and the remaining liquid, thus aiding the separation, which is completed by mechanical means.

The apparatus for making this test consists, essentially, of three glass parts—the test bottle, pipette, and acid measures—all of which must be accurately graduated. A centrifugal machine, the form of which may differ according to the ideas of the various manufacturers, completes the outfit.

Some Details of the Test.—The form of machine, which is convenient and dûrable, and has been in use at this Station over three years, is shown in the cut. It is sold by the Creamery Package Manufacturing Co., Chicago, Ill.

Fig. 2 shows the swinging heads and graduated test bottles in place; with the pipette, acid measure, a common milk bottle, and skim-milk bottle in front. The difference between these bottles consists in the latter being of double capacity, with a shorter neck, graduated by tenths for only 2 per cent., while the common bottles are graduated to 10 per cent. by fifths of one per cent. A bottle of commercial sulphuric acid of specific gravity about 1.82, is furnished with the apparatus from whatever manufacturer one is purchased.

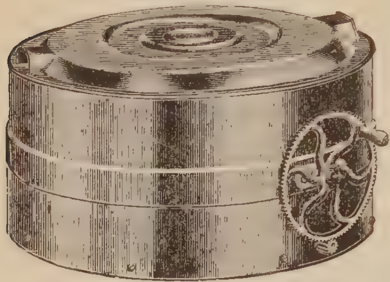

FIG. 1.—Babcock Milk Test.—Closed.

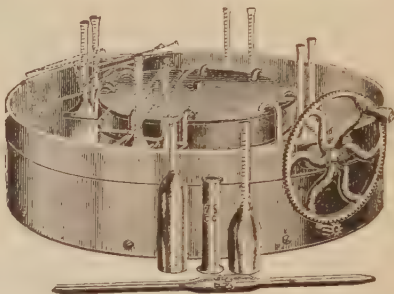

FIG. 2.—Babcock Milk Test.—Open.

There is no patent on this machine, thus allowing anyone to make and sell them. This may lead some to making cheap apparatus and inaccurately graduated bottles, acid measures or pipettes. In these particulars, accuracy must be obtained, or all results with the apparatus are vitiated. Be sure to buy machines and "extras" from responsible manufacturers or dealers. All the reputable dealers in dairy supplies make a special form of this "Test," or sell the make of some well-known manufacturer.

To make a Test.—Suppose it is desired to test the milk of a herd of cows, the operation will be performed about as follows: Weigh the milk pail, and after milking the first cow, weigh again. The differerence should show the yield of milk in pounds, of which very nearly 2 1-6 is one quart, or 8.65 pounds per gallon. Turn this milk into another pail through the strainer, rinse the milk-pail clean, dry it, and pour the milk back into the milk-pail gently. It may run down the side of the pail slightly tilted for that purpose. Do this several times, and immediately take the sample by drawing the pipette full to the mark, applying the lips to the top of the pipette for this purpose, and allowing it to run back into the pail; then draw the milk again up exactly to the mark and allow the contents of the pipette to run into the test bottle. To do this easily, requires a little practice and experience. Take a second sample, in the same way for a duplicate test and to balance the first bottle when placed in the machine, if but one test is to be made. If more tests are made, a cotton seed with adhering lint may be laid on the top of each bottle, until all cows have been milked and the milk sampled. Now fill the acid measure to the mark with the sulphuric acid, and let it flow into the test bottle with the milk, then add another measure of acid into

the duplicate bottle and shake both with a gentle, whirling motion until the milk appears to have been all dissolved. Do this for all the samples, or until a sufficient number to fill the machine has been taken. Now place the bottles in the revolving heads so as to balance the whole if the machine will not be full, put on the cover and turn the crank four or five minutes. The rate of speed attained per minute affects the time required considerably. One thousand revolutions of the head for three minutes (if the machine and bottles will bear so much speed) will be much more effeetive than five hundred revolutions for six minutes. Stop the machine and fill the bottles with boiling water to near the 10 per cent. mark on the neck, replace them and turn at about the same speed as before one minute. Prepare a vessel of water at 140° F., in which the water stands at a height just sufficient to cover the fat in the neck of the bottles. Set the bottles into this, and, after a minute, to let the contents come to the temperature of the water, lift out by the top of the neck, hold up level with the eye and read quickly the graduation at the top and at the bottom of the column of fat (see Fig. 3).

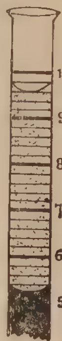

Fig. 3. Reading a Test Bottle.

The dark-colored liquid under the clear fat reaches up on the scale to 5 and one space above, while at the sides the fat does not show quite so low down. At the top the fat is solid at 9 and three spaces, but reaches up a little higher where it comes in contact with the glass. The bottom of the curved surface of the liquid should in all cases be read instead of the top of the curve. The spaces between the figures being five in number, represent fifths, and each space represents twenty hundredths (.20) of one per cent. The top reads nine and sixty hundredths, while the bottom reads five and twenty hundredths. The difference, four and forty hundredths, is the per cent. of fat in the milk tested. If the difference of readings for both bottles is the same, the tests duplicate and the result is correct. If one is 4.40 and the other is 4.50 or 4.60, one is wrong and another trial should be made, or the average of the two taken as the correct per cent. This average would be 4.45 or 4.50.

$$\begin{array}{r} 9.60 \\ 5.20 \\ \hline 4.40 \end{array}$$

If, in making the test, one bottle should show a black precipitate or dark particles in the fat, it would indicate too strong or too much acid has been used; while the presence of a light, gray-colored precipitate would indicate too little or too weak acid. The former cannot be corrected, and the tests will be lost; but sometimes the gray precipitate may be dissolved by adding a few drops more of acid, and the test saved. Especially can this be done by filling the bottles with boiling water only to the base of the neck, then shake carefully, whirling before adding the final amount of water in the neck. If the fat is clear, complete the filling at once, and finish the test. If the gray precipitate is still shown, add a few drops of acid, reshake and proceed with the test.

In using a weak acid, make separate trials, using more and more

acid until the right volume is found, or cool the acid, thus reducing volume and increasing the strength. A strong acid may be reduced so as to work with the regular amount, 17.5 cubic centimeters; but if not too strong it will be better practice to test for the right volume to use by taking a little less each time.

To standardize strong sulphuric acid, thin glass, porcelain, or lead vessels are required; also a hydrometer for specific gravity graduated to measure liquids from 1.8 to 2.0 times heavier than water, and a glass jar 12 inches deep and 1 to $1\frac{1}{2}$ inches inside diameter.

When acid has strength less than specific gravity 1.82 at 60°F., the only way to make good tests by its use is to increase the amount until enough is taken to secure a clear separation of the fat.

With acid testing 1.83 specific gravity, Mr. Bartlett, of the Maine Experiment Station, has found the proper strength by adding to the acid 1-20 of its volume of pure water or clear rain water. This is 5 per cent. With stronger acid more water than is proportional to the above must be added, because there is a reduction in volume when the water and acid unite.

Acid testing 1.845 specific gravity at 60°F. requires 15.5 per cent. of its volume of water to reduce it to 1.82, the standard for testing milk. If acid is to be used at a high temperature, as in summer at 75 to 90°F., 3-20 volume of water would be sufficient. Specific gravity changes about .001 for 1.0°F.

In adding water to acid, care must be exercised, as great heat is generated, and if done rapidly this may do harm by breaking the vessel. Add a few drops, then stir with a glass rod. Continue this until water is all added. If the mixing is done in glass, the addition must be very slow and the liquid frequently mixed by stirring, or other means, until the whole of the water added has united with the acid and the temperature has become uniform. Failure to do this with care may cause serious accidents by breakage of thick glass from unequal heating. It is better to add the acid to the water instead of the water to the acid, if it can be done conveniently.

Conveniences.—In making these tests in a dairy not provided with a laboratory sink, the acid from the bottles may do harm. To obviate this, and also for convenience, we put a small lead-lined sink against the wall of the work-room at the end of the table on which the centrifugal machine is worked. The lead pipe leading from this passes into our tile drain below the iron trap, which would otherwise be destroyed by the acid. The sink shown in Fig. 4 is of wood, and can be easily constructed. It is held in place by screws or nails. The lead may be fitted in by spreading the top of the pipe by means of a round pointed hardwood pin larger than the diameter of the pipe. After the pipe is in place, fit in a piece of sheet lead two or three inches larger than the bottom of the sink. Rub this down with a piece of smooth hardwood until it fits the bottom, and allow the edges to rise on the sides of the sink one or more inches. Now fit the sides of the sink with a similar sheet, the lower edge of which

laps down to within one-fourth inch of the lead bottom of the sink. Make a small hole over the pipe in the bottom of the sink, and with the pin used to open the pipe, work the hole larger and press down the edges to fit in order to carry fluids down into the pipe. A little plaster of paris could be used to tighten the joints, if desired; but if the sink is not to be flooded, this will not be necessary.

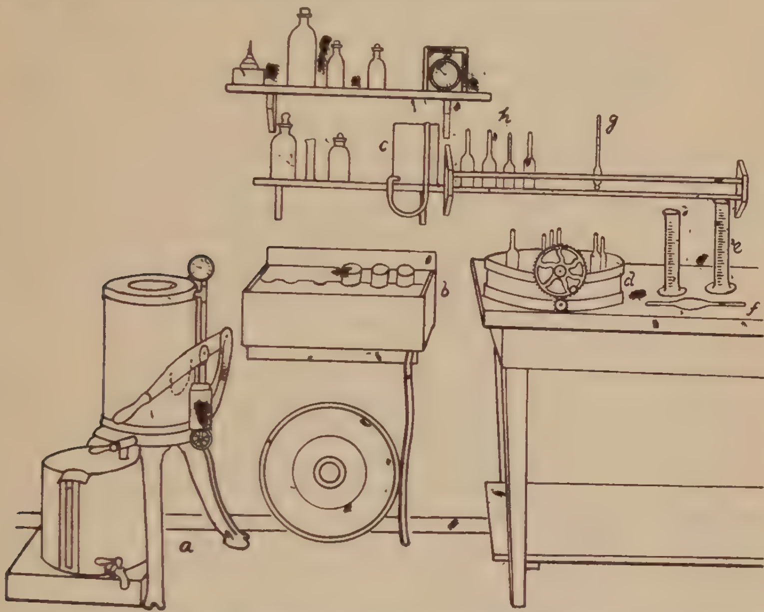

FIG. 4.—Conveniences for milk testing. *a*. Berrigan Separator (for trial). *b*. Sink for washing test bottles. *c*. Hot water can. *d*. Babcock milk tester. *e*. Measuring jars. *f*. Pipette. *g*. Lactometer. *h*. Testing bottles.

This sink is fitted with a wooden bottle-drainer, in which bottles to be emptied are laid after they have been shaken sufficiently to loosen the ash of the milk at the bottom. When the residue of the contents is drained out, the bottles are immediately filled with hot water and emptied, and the same repeated once or twice before being finally cleaned, if need be, with some alkali.

Two shelves above the sink serve for the acid and hot-water can, the dairy clock and other articles. The hot-water can is a one gallon can, 7¾ inches high, used in pouring milk to be sampled, and to hold the bottles when put into water at 140°F. during the test. When the fat has been read and recorded, this can is transferred from bench to shelf and a siphon tube with pinch cock, as shown in cut, is useful to fill the bottles in cleaning them.

An additional narrow shelf, resembling a test-tube holder, serves as a safe place for test bottles of different sizes.

Testing Skim or Buttermilk.—The method is the same as for milk, except that two measures of milk and two of acid are required. It will be found best to shake up the two measures of milk with only one of acid, then put in the second measure of acid and complete

the mixing. In revolving the machine with these large bottles, remember that the contents are heavier and turn slower to avoid breakage.

Testing Cream.—This can be done by dividing a pipette of thin cream between several bottles and adding water enough to each to make the required amount of 17.5 c.c. intended to be put into each bottle, and adding one measure of acid in each bottle. There are so wide variations in cream, and it is so rich in fat, that only special apparatus will give satisfactory results. These have been designed by Jas. S. Bartlett, M. S., Chemist to the Maine Experiment Station, and can be obtained of Emil Greiner, New York City.

In testing cream, Mr. Bartlett has shown that to secure accurate results, the samples must be weighed out after thoroughly mixing the same as for milk.* For a test, 18 grams of cream should be used. A No. 302 Handy Scale, made by Springer Torsion Balance Co., 92 Reade St., N. Y., is recommended for the weighing. A special weight which is required should be mentioned in ordering it. The balance costs, as Mr. Bartlett states, "about $4.00, with a weight that, when put on the 8 oz. notch, weighs 18 grams."

Testing Condensed Milk and Cheese.—These may also be tested for fat by this test, according to Dr. Babcock's directions:** "To those who have facilities for weighing, it offers a rapid and quite accurate method for the estimation of fat in condensed milk and in cheese. For the examination of condensed milk, about eight grams may be weighed into a test bottle; then, after adding about 10 c.c. of water, the test may be conducted in the same way as with milk, the per cent. of fat being obtained by multiplying the reading by 18, and dividing the product by the weight, in grams, of substance taken for the test. The results with condensed milk are quite satisfactory."

"For the estimation of fat in cheese about 5 grams should be carefully weighed and transferred as completely as possible to a test bottle. From 12 to 15 c. c. of hot water are then added, and the bottle shaken at intervals, keeping them warm, until the cheese has become softened. After the contents of the bottles have become cold the usual amount of acid should be added, and the bottles shaken until the lumps of cheese have entirely dissolved. The bottles are then placed in the machine and whirled, the test being completed in the same manner as with milk. To obtain the per cent. of fat, the reading should be multiplied by 18 and the product divided by the weight, in grams, of cheese taken. With rich cheese, the errors incident to sampling, to imperfect graduation of tubes, and to incorrect measurements of the column of fat, are multiplied by so large a factor that duplicate determinations with the same cheese are only approximate. With cheese containing less that 20 per cent. of fat, the results are quite satisfactory."

"The sources of error, when the test is applied to the examination

*Maine Experiment Station Bulletin No. 3, Second Series, September 1, 1891.

**Bulletin No. 31, Wisconsin Experiment Station.

of butter are so large, owing to the high per cent. of fat which butter contains, that the method is not recommended for this purpose."

The Composite Test.—This test, like others, was worked out chiefly to help the creamery men and cooperative associations, against those who might try to obtain something for nothing. In this phase of it, no one has been disappointed, for this test meets their needs better than could have been anticipated. More than that, it is finding a much wider field, and no wide-awake dairyman is now satisfied to be without this test, to determine definitely the relative value of each one of his cows. In this respect no one would have ventured to predict so wide a usefulness as has already been developed by this simple test. The work of testing cows may be simplified by using this composite test, which has been evolved in the effort to save labor for creamery men. For the benefit of those who may wish to use this test in testing cows, as well as for others who can employ it to good advantage in cooperative dairying, Dr Babcock's bulletin is here freely quoted: *

"Although it is quite generally admitted that the quality as well as quantity of milk delivered, should be considered in making dividends in factories where milk is pooled, many who recognize the justice of the relative value, hesitate to adopt it, on account of the labor and expense involved in making daily tests from each patron's milk. The best plan yet proposed for reducing the expense of the necessary tests, is that first described by Prof. Patrick in Bulletin No. 9, of the Iowa Experiment Station. This plan consists in putting a sample from each lot of milk which a patrom delivers, successively into a fruit jar or other suitable vessel which can be tightly closed, and, after a number of days, ascertain the average per cent. of fat in all of the milk delivered by the patron, for the time considered, by a single test of the composite sample. In order that the composite sample may truly represent the average of all the milk delivered by a patron, the daily supply should, of course, be proportioned to the amount of milk which he delivers each day. It has been found, however, in practice, that scarcely an error is introduced when the daily samples are of uniform size. Prof. Patrick recommended that a small quantity of corrosive sublimate be placed in the jar in which the composite sample is kept, in order to prevent the souring of the milk and keep it in a condition which admits of a representative sample being taken for analysis. On account of the very poisonous nature of corrosive sublimate, it is to be discouraged, if the same end can be obtained by other means that are not dangerous.

"Numerous experiments have shown that the addition of 5 per cent., by volume, of strong ammonia water, as recommended on page 7, of this bulletin (Bulletin 31) for taking samples of sour milk will givê satisfactory results with the composite sample. If ammonia is

* Bulletin No. 31, Wisconsin Agricultural Experiment Station.

used the reading should be increased by one twentieth of itself, to obtain the per cent. of fat.

"For factories having a large number of patrons, the method of using the composite test, proposed by Mr. Farrington, chemist of the Illinois Experiment Station, is recommended. This consists in adding to the three-fourths of a quart of soured milk, which comprises the composite sample, about one-half a teaspoonful of 'concentrated' or 'powdered lye,' such as is sold by grocers for making soap. In regard to its use, Mr. Farrington says: * 'By the action of this concentrated alkali the acid of the sour milk is neutralized and the curd dissolved, so that by pouring the milk from one jar to another it soon becomes completely mixed, and can be successfully tested. The action of the lye on the sour milk is hastened by adding it to the milk in small quantities so that the lye is dissolved. If one-half a teaspoonful of the lye is thrown into the milk at once it collects together in a hard lump, which dissolves with difficulty. The whole process of thinning the thick sour milk with lye is aided by warming the milk at a temperature of 100° to 140° F., and by letting it stand for an hour or more. The time and heat both help the solvent action. Pouring from one jar to another is also an important factor in getting the milk thoroughly mixed.' In making tests on this plan, a quart fruit jar should be provided for each patron, into which a measured sample of the milk, which he brings each day, is placed. A small tin cylinder, holding about one-tenth of a quart when filled to the brim, makes a convenient measure for this purpose. Whenever a fresh sample of milk is placed in the jar it should be mixed with the milk previously added by giving the milk a rotary motion; unless this is done, the cream which separates may adhere tenaciously to the sides of the jar and prevent the taking of an accurate sample when the test is made.

"The jars should be kept tightly closed after each sample of milk is added, and should be kept in a cool place during the week. When ready for the test, about one-half teaspoonful of the powdered lye is added, in small portions at a time, to each jar, which should be shaken occasionally, or poured from one jar to another, until the curdled milk has all dissolved and the cream become mingled with the milk. Solution may be hastened by warming the contents of the jar to a little over 100° F. The temperature should not exceed 140° F., and the covers should be kept upon the jars when warmed to prevent evaporation. When the milk in the jar has become thin and homogeneous, a sample may be measured and tested for fat in exactly the same way as with new milk, the result being the average per cent. of fat in the milk delivered for the period covered by the samples. Tests of this kind should not extend over a longer period than one week."

This composite test leads to, and in many cases makes possible,

* Bulletin 16, Illinois Agricultural Experiment Station, 1891, p. 510.

the relative value plan of apportioning dividends. When one has followed out one calculation to show how it is done, he need go no further, for one formula may answer to illustrate the method. We give below a possible case, which might occur in either the Statesville or Charlotte creamery, or which may be experienced by three or four, or a dozen farmers in any country neighborhood who can agree to pool their milk and let it all be made up together by the best butter-maker in the neighborhood.

The Co-operative, or Relative-value Plan of Paying for Milk.—Each man is supposed to receive exactly what his milk is worth according to the amount of butter fat which is found in it. For a factory where the patrons have found profit in producing milk, it may be assumed that ten times as much milk will be furnished than where a few farmers commence to try the system a few months before investing very heavily in it. Therefore the amounts given may be regarded as ten times greater when applied to creamery work, and the smaller amounts furnished can be estimated by moving the decimal points one place further to the left.

NAMES OF PATRONS.	GALLONS PER DAY.	POUNDS OF MILK FURNISHED IN THIRTY DAYS.	PER CENT. OF FAT.	POUNDS OF FAT FURNISHED IN THIRTY DAYS.
D	40 5	10200.	5.00	510.
G	12.3	3150.	4.50	141 75
K	12.3	3150.	5.50	173.25
L	17.3	4500.	6.00	270.
M	177.0	45900.	4.00	1836.
T	42.8	11100.	4.80	532.8
				3463.8

The per cent. of fat indicates pounds in 100 pounds of milk. If we consider the pounds of milk furnished by any one man divided by one hundred as moving the decimal point two places toward the left, then the number of hundred pounds should be multiplied by the number denoting the pounds of fat in one hundred pounds of milk, thus: For *D*, 102 $\times$ 5. = 510. pounds of fat.

For these thirty days, we will suppose, the butter-maker made five composite tests and had carried out the pounds of fat five times instead of once, as shown above. Then the five results were added to get the total fat for the full time. He found he had made 3672. pounds of butter, which, at the wholesale price of 25 cents, brought $918.00, while the charge for making, freight, sales and collecting, previously agreed upon at 5 cents per pound, amounted to $183.60. Thus, $734 40 is to be divided among *D*, *G*, *K*, *L*, *M* and *T* in proportion to the amount of fat furnished by each. There were 3463.8 pounds of fat produced, which brought $734.40. Divide 734.40 by 3463.8, and the quotient (21.202) shows the number of cents to be

credited for each pound of fat. As each man had been credited with the proper number of pounds of fat when it was determined, it remains now only to turn to the proper place, enter the cents per pound of fat (21.202) and carry out the multiplication for each one, for *D*, for example, 510. $\times$ 21.202 = 10813 cents, or pointing off two places to reduce to dollars, $108.13.

Had *D* been one of a few who were investigating the value of the co-operative plan, he would have furnished, according to this calculation, 1020. pounds of milk containing 51 pounds of fat, and he would, at the same rate for making and sales, have received $10.81. M., who might have been employed to work up the milk for the other five with his own, would receive $18.36 for doing all the work and the amount in the following table, $38.93, opposite his name for his equitable share in the pooled milk. For convenience the multiplier to represent cents per pound is written as a decimal of a dollar in the table, and the dollars are pointed off correctly at first.

NAMES OF PATRONS.		RELATIVE SHARE OF EACH PATRON.
D	510. x .21202 =	$ 108.13
G	141.75 x .21202 =	30.05
K	173.25 x .21202 =	36.73
L	270. x .21202 =	57.25
M	1836. x .21202 =	389.27
T	532.8 x .21202 =	112.97
		$ 734.40

It was stated the above might be a possible case. Note that *G* and *K* furnished equal amounts of milk which, if sold at a regular price for milk, would have given the same amount of money to each man. But on finding the exact value of the milk furnished by each for butter making, it has been shown that *K* was paid $6.68 cents more than *G* received for his milk. To have paid the same on the ground that milk is milk would have been a gross injustice to *K*, while *G* would have received money which did not belong to him, just as rank an injustice, but one not so likely to be complained of, or that would be likely to make him withdraw his milk, as he might do in the case worked out. What greater incentive for a man to improve his stock, his feeding and his farm management than *G* received in being so far distanced in equal weights of milk? Wider differences than these are of frequent occurrence. Among individual cows these differences occur in every herd, hence *G* should at once institute a search by the Babcock Test for the cows which were depressing his record and for those which were giving best returns in order to recover in the near future from his backward position.

The Russian Pipette.—This pipette is filled as shown in Fig. 5, and is claimed to do very good work. The advantages claimed for it are greater accuracy and more rapid work. We wished to recommend it, if possible, to those who may have difficulty in catching the milk quickly at the mark by the common pipette. This is easy for a skilful hand, but for a man whose fingers have become hardened with labor, to catch the milk quickly and accurately in the common pipette, will require considerable patience. The pipette, properly held as shown above, gives very accurate work. We have tried it, but prefer the common pipette as being more rapid in our hands, and also as accurate. Another point against this pipette is its bluntness, and that it must be held very exactly, and that the milk must be drawn from near the surface. This prevented the drawing the sample from certain desirable vessels which we had in use. Broad, shallow sample bottles are needed with this pipette.

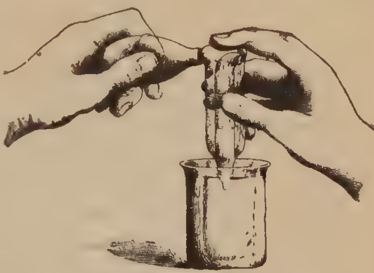

FIG. 5.—THE RUSSIAN PIPETTE.

II. THE DETECTION OF ADULTERATIONS IN MILK.

Under this head Dr. S. M. Babcock has given* a simple method by which anyone possessing a lactometer and Babcock Tester could detect the fact if milk were skimmed, or had much water added to it. This test is intended also for factorymen and milk dealers who do not use the Babcock Test to determine the quantity of fat in the milk purchased as the basis of valuation.

A part of this article is reproduced below with the formulas and table for determining the solids not fat. This is not reprinted because of any demand for it, but rather to place a simple and reliable check in the hands of North Carolina dairymen to the end that they may be prepared to accept and use it should occasion require. This feature of the Babcock Test is valuable in other ways, as it enables the determination of the solids not fat with a reasonable degree of accuracy; and it may be used in testing cows where it is desired to learn more of the milk than the per cent. of fat contained in it.

For the convenience of private dairymen who may wish to test the milk of family cows and determine the solids not fat, an extension of the table showing per cent. of solids not fat corresponding to given readings of the lactometer and percentages of fat above 6 per cent. to 9 per cent. has been added. Even this extension does not reach the limit we have found in special cases, but it will cover most of the milk that is richer than 6 per cent. fat.

Detection of Adulterations in Milk.†

"The most usual adulterations of milk are the addition of water and the abstraction of fat. Those factorymen and dealers who pay for milk according to its quality, as recommended in this bulletin, need have no fears of either of these adulterations as the system makes it the interest of every man to supply as good milk as possible. As there are, however, many factories that still cling to the old method of paying the same price for all milks independent of their quality, it is thought advisable to describe the methods by which such frauds may be detected.

"The detection of these adulterations is rendered possible by the fact that the abstraction of cream reduces the per cent. of fat and slightly increases the per cent. of solids not fat in the milk which remains. On the other hand the addition of water reduces the per cent. of butter fat and solids not fat, in proportion to the amount of water added. For example: If a milk which originally tested 4 per cent. of fat and 9 per cent. of solids not fat be skimmed so that the remaining milk tests only 2 per cent. of fat, the solids not fat in the skimmed milk would be about 9.2 per cent. If on the other hand, enough water had been added to this milk to reduce the fat to 2 per cent. the solids not fat would have been only 4.5 per cent. It is therefore easy to detect either or both of these adulterations, if a sample of the original milk can be obtained; as it is rarely possible in sus-

* Bulletin No. 31, Wisconsin Agricultural Experiment Station.

† Extracted from Bulletin 31 of the Wisconsin Experiment Station, by Dr. S. M. Babcock.

pected cases to obtain original samples, it is best when practicable, to secure through an authorized agent, who sees the cows milked, a sample of milk from the same herd with which comparisons may be made. As the amount of fat and solids not fat in the mixed milk from a herd are quite constant in quantity, the fat not usually varying more than .3 per cent. from one day to another, and the solids not fat even less, the sample taken at the farm should correspond within narrow limits with previous samples taken from the milk wagon.

"In order to maintain a fair quality of milk and insure the public against frauds, many states have established, by law, certain standards which fix the minimum amount of fat and of solids not fat, which commercial milk shall contain, and in such States it is illegal to sell milk, as pure, which falls below the standard. It makes no difference whether the milk is poor from watering, from skimming, or from poor cows, the penalty is the same in all cases.

"In Wisconsin the legal standard for fat is three per cent., which is as low as any accepted standard in this country or Europe. In other states the standard ranges from 3 to 3.5 per cent. The general average for all breeds and for all seasons of the year is about 3 6 per cent. of fat, and it is rare for the mixed milk from any herd to fall below 3 per cent. It is possible that the milk from individual cows or from herds which contain only two or three cows, may contain less than the standard demands, but usually milk with less than 3 per cent. of fat has been either watered or skimmed.

"The legal standards for solids not fat established in England and in some of the eastern States is 9 per cent. In Wisconsin there is no legal standard for solids not fat. Milks containing less than 9 per cent. of solids not fat are suspicious, and those containing less than 8.5 are probably watered. In all suspected cases it is advisable, as already suggested, to secure samples from the farm for comparison.

"To detect the adulterations it is necessary to determine both the fat and the solids not fat. If either of these is below the legal standard, the milk must be considered adulterated even if it has not been tampered with after being milked. For purposes of inspection the fat may be determined by the method described in this bulletin. The solids not fat may be determined by the usual laboratory methods, or, for practical purposes, they may be calculated with sufficient accuracy from the specific gravity of the milk and the per cent. of fat. The specific gravity should be carefully determined for this purpose.

"The following precautions are essential: Milk just after it is drawn is saturated with air which should be allowed to escape before the specific gravity is determined, otherwise the result will be too low. To be on the safe side, milk should stand at least one hour after being milked before the test is made. The temperature of the milk should be brought by warming or cooling to 60° F., and then thoroughly mixed by pouring from one vessel to another with care to avoid, as much as possible, the introduction of small bubbles of air. The specific gravity may then be accurately determined with a picnometer or a Westphal balance, but for general purposes a good hydrometer or lactometer is sufficiently accurate, and on account of its convenience is to be preferred.

THE LACTOMETER.

"There are several kinds of lactometers in use at the present time, all of which have the same general form, viz.: a narrow stem to which is attached an elongated bulb weighted at the bottom so as to float in an upright position in milk, with the stem partially submerged. The depth to which the lactometer sinks depends upon the specific gravity of the liquid in which it is placed, a heavy liquid causing the stem to rise higher above the surface than a light liquid. It shows the relative weights of equal volumes of milk tested.

"The lactometer most generally used in this country is graduated from 0 to 120 degrees, 0 being the point on the stem to which the instrument sinks in pure water at 60° F. and 100 the point to which it sinks in a liquid having a specific gravity of 1.029, this being assumed to be the lowest specific gravity compatible with pure milk. The intermediate readings are intended to show the per cent. of milk having a specific gravity of 1 029, which the sample examined contains. This, however, it does not do, for when milk is skimmed it will give a higher reading upon the lactometer than it did before the cream was removed, and the addition of cream

*Extracted from Bulletin 31 of the Wisconsin Experiment Station, by Dr. S. M. Babcock.

to milk affects the reading in the same way as the addition of water. Although an experienced person would rarely if ever be deceived by these readings, owing to the changed appearance of milk that has been skimmed or watered, factorymen and others are often misled by them. For this reason and also because it is necessary when the readings are to be used, in connection with the per cent. of fat, for the calculation of total solids, to know the specific gravity of milk, the Quevenne lactometer is to be preferred. The scale of this lactometer expresses in thousandths the difference between the specific gravity of the liquid tested and water, the specific gravity of water being 1. In other words the reading of this lactometer is equal to the specific gravity of the milk in which it is placed, less 1 multiplied by 1,000. To illustrate, milk having a specific gravity of 1.0325 would give with this lactometer a reading of 32.5 and a reading of 33 on this lactometer, corresponds to a specific gravity of 1.033. It is therefore easy to convert lactometer degrees into specific gravity and specific gravity into lactometer degrees. These lactometers are usually graduated from 15 to 40 degrees; if the scale were extended to 0, this would be found at that point on the stem to which the instrument sinks in pure water at a temperature of 60° F. The 0 points of both of the lactometers mentioned correspond. The scale of the ordinary lactometer may be converted into the Quevenne scale by multiplying by .29. For convenience a table is given showing the relation between the two scales. The Quevenne readings are given to the nearest tenth.

Table showing the Quevenne lactometer degrees corresponding to the scale of the ordinary lactometers that are graduated from 0 to 120.

Ordinary Scale.	Quevenne Scale.	Ordinary Scale.	Quevenne Scale.	Ordinary Scale.	Quevenne Scale.	Ordinary Scale.	Quevenne Scale.
60	17.4	76	22.	92	26.7	108	31.3
61	17.7	77	22.3	93	27.	109	31.6
62	18.	78	22.6	94	27.3	110	31.9
63	18.3	79	22.9	95	27.6	111	32.2
64	18.6	80	23.2	96	27.8	112	32.5
65	18.8	81	23.5	97	28.1	113	32.8
66	19.1	82	23.8	98	28.4	114	33.1
67	19.4	83	24.1	99	28.7	115	33.4
68	19.7	84	24.4	100	29.	116	33.6
69	20.	85	24.6	101	29.3	117	33.9
70	20.3	86	24.9	102	29.6	118	34.2
71	20.6	87	25.2	103	29.9	119	34.5
72	20.9	88	25.5	104	30.2	120	34.8
73	21.2	89	25.8	105	30.5		
74	21.5	90	26.1	106	30.7		
75	21.7	91	26.4	107	31.		

"The sensitiveness of a lactometer depends upon the relation between the volume of the bulb and the diameter of the stem, a large bulb and small stem being most sensitive. A bulb $1\frac{1}{4}$ inch in diameter and 3 inches long with a stem about $\frac{1}{4}$ inch in diameter gives suitable proportions for a dairy lactometer. It is advisable to have the instrument combined with a thermometer, and when this is done it is more convenient to have the thermometer scale placed above the lactometer scale so that both scales can be read without removing the lactometer from the milk.

CORRECTIONS FOR TEMPERATURE.

"Although it is always advisable to have the temperature of the milk carefully adjusted to 60° F., when the lactometer reading is taken, corrections for the Quevenne lactometer may be made, for slight deviations (not more than 10°) from the standard temperature, without serious error, by adding to the lactometer reading 0.1 for each degree that the temperature exceeds 60, and subtracting 0.1 for each degree below 60. For example, the lactometer reading is 33.5 and the temperature of the milk is 67° F. The corrected reading for 60° would be 33.5+.7=34.2. Had the temperature been 56° F., the corrected reading would be 33.5—.4=33.1.

"Having obtained the per cent. of fat and specific gravity by the above or any

accurate method the solids not fat may be obtained by reference to the accompanying table which is calculated from the following formula: *

$$\text{Solids not fat} = \left(\frac{100\ S - Sf}{100 - 1.0753\ Sf} - 1 \right) \times (100 - f)\ 2.6$$

in which S=Specific gravity of milk at 60° F. and f=per cent of fat.

"The table gives per cents. of solids not fat corresponding to Quevenne lactometer readings (1000 sp. gr.—1000) from 17 to 40 and for each tenth per cent. of fat up to six per cent.

"To use the table find in the horizontal column the number corresponding to the Quevenne lactometer reading of the milk and follow along the vertical line in which this appears to the column with the per cent. of fat in the milk; the number common to both of these lines is the per cent. of solids not fat in the milk. To find the total solids' add the per cent. of solids not fat, as found in the table, to the per cent. of fat.

A SIMPLE FORMULA FOR THE SOLIDS NOT FAT.

"Among the numerous formulæ that have been proposed for the calculation of the solids of milk from the specific gravity and per cent. of fat, not one, that is sufficiently accurate for general use, is easily applied without tables and I believe the limited use of such formulæ in this country may be attributed to this fact. This objection does not hold with the formula given below as it is simple enough to be easily remembered and can be quickly applied without tables. At the same time the results obtained by it are, with normal milks containing not more than 6 per cent fat, nearly as accurate as are those by any other formula. For this reason I believe it to be well adapted to the wants of dairymen and others who may wish to know more about the composition of milk than is expressed by the amount of fat. This formula has been used the past two winters by students in the Dairy School at the University of Wisconsin and by it they have been enabled, in most cases, to detect the common adulterations of milk, such as the abstraction of fat or the addition of water.

"The formula is as follows:

$$\text{Solids not fat} = \frac{L + .7\ f}{3.8} \text{ and}$$

$$\text{Total solids} = \frac{L + .7\ f}{3.8} + f$$

in which L= Reading of Quevenne lactometer at 60° F. and f = per cent of fat.

"This formula agrees with the more general formula, by which the table is calculated, when applied to milks containing between 3 and 4 per cent. of fat. For milks containing less than 3 per cent. of fat the formula gives results a trifle too high, and for milks above 4 per cent. of fat a trifle too low, the error, however, will not amount to as much as .1 per cent. with any normal milk containing less than 6 per cent. of fat. If more accurate results are desired the solids not fat as found by this formula may be corrected as follows:

For milks containing less than 1 pct. of fat substract............. .09
For milks containing from 1 to 2 pct. of fat substract .... .06
For milks containing from 2 to 3 pct. of fat substract .... .03
For milks containing from 3 to 4 pct. of fat ....no correction.
For milks containing from 4 to 5 pct. of fat add .... .03
For milks containing from 5 to 6 pct. of fat add .... .06

and so on, adding .03 to the solids not fat, as shown by the formula, for each per cent. of fat above 4 which the milk contains. Corrected in this way the results will agree closely with those obtained by the general formula, for milks or creams containing not more than 20 per cent. of fat.

"For ordinary purposes no correction need be applied as the errors of observation, in obtaining the necessary data, would generally be greater than those arising from defects in the formula.

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* See 8th Annual Report of Wisconsin Agricultural Experiment Station.

Table Showing per cent. of Solids not Fat Corresponding to per cent. of Fat and Quevenne Lactometer Reading.

Per cent. of fat	Lactometer Reading. 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Per cent. of fat.
0.1	4.44	4.70	4.96	5.22	5.48	5.74	6.00	6.26	6.52	6.78	7.04	7.30	7.56	7.82	8.08	8.34	8.60	8.86	9.12	9.38	9.64	9.90	10.16	10.42	0.1
0.2	4.46	4.72	4.98	5.24	5.50	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.58	7.84	8.10	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	0.2
0.3	4.48	4.74	5.00	5.26	5.52	5.78	6.04	6.30	6.56	6.82	7.08	7.34	7.60	7.86	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	0.3
0.4	4.50	4.76	5.02	5.28	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.36	7.62	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.97	10.23	10.49	0.4
0.5	4.52	4.78	5.04	5.30	5.56	5.82	6.08	6.34	6.60	6.86	7.12	7.38	7.64	7.90	8.16	8.42	8.68	8.95	9.21	9.47	9.73	9.99	10.25	10.51	0.5
0.6	3.54	4.80	5.06	5.32	5.58	5.84	6.10	6.36	6.62	6.88	7.14	7.40	7.66	7.93	8.19	8.45	8.71	8.97	9.23	9.49	9.75	10.01	40.27	10.53	0.6
0.7	4.56	4.82	5.08	5.34	5.60	5.86	6.12	6.38	6.64	6.91	7.17	7.43	7.69	7.95	8.21	8.47	8.73	8.99	9.25	9.51	9.77	10.03	10.29	10.55	0.7
0.8	4.58	4.84	5.10	5.36	5.62	5.88	6.14	6.40	6.67	6.93	7.19	7.45	7.71	7.97	8.23	8.49	8.75	9.0.	9.27	9.53	9.79	10.05	10.31	10.57	0.8
0.9	4.60	4.86	5.12	5.38	5.64	5.90	6.17	6.43	6.69	6.95	7.21	7.47	7.73	7.99	8.25	8.51	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	0.9
1.0	4.62	4.88	5.14	5.40	5.66	5.93	6.19	6.45	6.71	6.97	7.23	7.49	7.75	8.01	8.27	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.61	1.0
1.1	4.64	4.90	5.17	5.43	5.69	5.95	6.21	6.47	6.73	6.99	7.25	7.51	7.77	8.03	8.29	8.55	8.81	9.07	9.33	9.59	9.85	10.12	10.38	10.64	1.1
1.2	4.66	4.92	5.19	5.45	5.71	5.97	6.23	6.49	6.75	7.01	7.27	7.53	7.79	8.05	8.31	8.57	8.83	9.09	9.35	9.62	9.88	10.14	10.40	10.66	1.2
1.3	4.68	4.95	5.21	5.47	5.73	5.99	6.25	6.51	6.77	7.03	7.29	7.55	7.81	8.07	8.33	8.59	8.85	9.12	9.38	9.64	9.90	10.16	10.42	10.68	1.3
1.4	4.70	4.97	5.23	5.49	5.75	6.01	6.27	6.53	6.79	7.05	7.31	7.57	7.83	8.09	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	10.70	1.4
1.5	4.73	4.99	5.25	5.51	5.77	6.03	6.29	6.55	6.81	7.07	7.33	7.59	7.85	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	00.20	10.46	10.72	1.5
1.6	4.75	5.01	5.27	5.53	5.79	6.05	6.31	6.57	6.83	7.09	6.35	7.61	7.88	8.14	8.40	8.66	8.92	9.18	9.44	9.70	9.96	10.22	10.48	10.75	1.6
1.7	4.77	5.03	5.29	5.55	5.81	6.07	6.33	6.59	6.85	7.11	7.38	7.64	7.90	8.16	8.42	8.68	8.64	9.20	9.46	9.72	9.98	10.25	10.51	10.77	1.7
1.8	4.79	5.05	5.31	5.57	5.83	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.18	8.44	8.70	8.96	9.22	9.48	9.75	10.01	10.27	00.53	10.79	1.8
1.9	4.81	5.07	5.33	5.59	5.85	6.11	6.37	6.63	6.90	7.16	7.42	7.68	7.94	8.20	8.46	8.72	8.98	9.24	9.51	9.77	10.03	10.29	10.55	10.81	1.9
2.0	4.83	5.09	5.35	5.61	5.87	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.96	8.22	8.48	8.74	9.01	9.27	9.53	9.79	10.05	10.31	10.57	10.83	2.0
2.1	4.85	5.11	5.37	5.63	5.89	6.15	6.41	6.68	6.94	7.20	7.46	7.72	7.98	8.24	8.50	8.77	9.03	9.29	9.55	9.81	10.07	10.33	10.59	10.86	2.1
2.2	4.87	5.13	5.39	5.65	5.91	6.17	6.44	6.70	6.96	7.22	7.48	7.74	8.00	8.26	8.53	8.79	9.05	9.31	9.57	9.83	10.09	10.35	10.62	10.88	2.2
2.3	4.89	5.15	5.41	5.67	5.93	6.19	6.46	6.72	6.98	7.24	7.50	7.76	8.02	8.29	8.55	8.81	9.07	9.33	9.59	9.85	10.11	10.38	10.64	10.90	2.3
2.4	4.91	5.17	5.43	5.69	5.95	6.22	6.48	6.74	7.00	7.26	7.52	7.78	8.05	8.31	8.57	8.83	9.09	9.35	9.61	9.87	10.14	10.40	10.66	10.92	2.4

Table Showing per cent. of Solids not Fat Corresponding to per cent. of Fat and Quevenne Lactometer Reading.

Per cent. of Fat.	Lactometer Reading.																							Per cent of Fat.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
2.5	4.93	5.19	5.45	5.71	5.98	6.24	6.50	6.76	7.02	7.28	7.54	7.81	8.07	8.33	8.59	8.85	9.11	9.37	9.63	9.90	10.16	10.42	18.68	10.94	2.5
2.6	4.95	5.21	5.47	5.73	6.00	6.26	6.52	6.78	7.04	7.30	7.56	7.83	8.09	8.35	8.61	8.87	9.13	9.39	9.66	9.92	10.18	10.44	10.70	10.96	2.6
2.7	4.97	5.23	5.49	5.76	6.02	6.28	6.54	6.80	7.06	7.32	7.59	7.85	8.11	8.37	8.63	8.89	9.16	9.42	9.68	9.94	10.20	10.46	10.72	10.99	2.7
2.8	4.99	5.25	5.51	5.78	6.04	6.30	6.56	6.82	7.08	7.35	7.61	7.87	8.13	8.39	8.65	8.92	9.18	6.44	9.70	9.96	10.22	10.48	10.75	11.01	2.8
2.9	5.01	5.27	5.54	5.80	6.06	6.32	6.58	6.84	7.10	7.37	7.63	7.89	8.15	8.41	8.67	8.94	9.20	9.46	9.72	9.98	10.24	10.51	10.77	11.03	2.9
3.0	5.03	5.29	5.56	5.82	6.08	6.34	6.60	6.86	7.13	7.39	7.65	7.91	8.17	8.43	8.70	8.96	9.22	9.48	9.74	10.00	10.27	10.53	10.79	01.05	3.0
3.1	5.05	5.31	5.58	5.84	6.10	6.36	6.62	6.88	7.15	7.41	7.67	7.93	8.19	8.46	8.72	8.98	9.24	9.50	9.76	10.03	10.29	10.55	10.81	11.07	3.1
8.2	5.07	5.33	5.60	5.86	6.12	6.38	6.64	6.90	7.17	7.43	7.69	7.95	8.21	8.48	8.74	9.00	9.26	9.52	9.79	10.05	10.31	10.57	10.83	11.09	3.2
3.3	5.09	5.36	5.62	5.88	6.14	6.40	6.66	6.93	7.19	7.45	7.71	7.97	8.24	8.50	8.76	9.02	9.28	9.55	9.81	10.07	10.33	10.59	10.85	11.12	3.3
3.4	5.11	5.38	5.64	5.90	6.16	6.42	6.69	6.95	7.21	7.47	7.73	8.00	8.26	8.52	8.78	9.04	9.30	9.57	9.83	10.09	10.35	10.61	10.88	11.14	3.4
3.5	5.14	5.40	5.66	5.92	6.18	6.44	6.71	6.97	7.23	7.49	7.75	8.02	8.28	8.54	8.80	9.06	9.33	9.59	9.85	10.11	10.37	10.64	10.90	11.16	3.5
3.6	5.16	5.42	5.68	5.94	6.20	6.46	6.73	6.99	7.25	7.51	7.78	8.04	8.30	8.56	8.82	9.09	9.35	9.61	9.87	10.13	10.40	10.66	10.92	11.18	3.6
3.7	5.18	5.44	5.70	5.96	6.22	6.49	6.75	7.01	7.27	7.53	7.80	8.06	8.32	8.58	8.84	9.11	9.37	9.63	9.89	10.16	10.42	10.68	10.94	11.20	3.7
3.8	5.20	5.46	5.72	5.98	6.24	6.51	6.77	7.03	7.29	7.56	7.82	8.08	8.34	8.60	8.87	9.13	9.39	9.65	9.91	10.18	10.44	10.70	10.96	11.23	3.8
3.9	5.22	5.48	5.74	6.00	6.27	6.53	6.79	7.05	7.31	7.58	7.84	8.10	8.36	8.63	8.89	9.15	9.41	9.67	9.94	10.20	10.46	10.72	10.99	11.25	3.9
4.0	5.24	5.50	5.76	6.02	6.29	6.55	7.81	7.07	7.34	7.60	7.86	8.12	8.38	8.65	8.91	9.17	9.43	9.70	9.96	10.22	10.48	10.75	11.01	11.27	4.0
4.1	5.26	5.52	5.78	6.04	6.31	6.57	6.83	7.09	7.36	7.62	7.88	8.14	8.41	8.67	8.93	9.19	9.46	9.72	9.98	10.24	10.50	10.77	11.03	11.29	4.1
4.2	5.28	5.54	5.80	6.07	6.33	6.59	6.85	7.12	7.38	7.64	7.90	8.16	8.43	8.69	8.95	9.21	9.48	9.74	10.00	10.26	10.53	10.79	11.05	11.31	4.2
4.3	5.30	5.56	5.82	6.09	6.35	6.61	6.87	7.14	7.40	7.66	7.92	8.19	8.45	8.71	8.97	9.24	9.50	9.76	10.02	10.29	10.55	10.81	11.07	11.34	4.3
4.4	5.32	5.58	5.84	6.11	6.37	6.63	6.89	7.16	7.42	7.68	7.94	8.21	8.47	8.73	8.99	9.26	9.52	9.78	10.04	10.31	10.57	10.83	11.09	11.36	4.4
4.5	5.34	5.60	5.86	6.13	6.39	6.65	6.92	7.18	7.44	7.70	7.97	8.23	8.49	8.75	9.02	9.28	9.54	9.80	10.07	10.33	10.59	10.85	11.12	11.38	4.5
4.6	5.36	5.62	5.89	6.15	6.41	6.67	6.94	7.20	7.46	7.73	7.99	8.25	8.51	8.77	9.04	9.30	9.56	9.83	10.09	10.35	10.61	10.88	11.14	11.40	4.6
4.7	5.38	5.64	5.91	6.17	6.43	6.69	6.96	7.22	7.48	7.75	8.01	8.27	8.53	8.80	9.06	9.32	9.58	9.85	10.11	10.37	10.64	10.90	11.16	11.42	4.7
4.8	5.40	5.66	5.93	6.19	6.45	6.72	6.98	7.24	7.50	7.77	8.03	8.29	8.55	8.82	9.08	9.34	9.61	9.87	10.13	10.39	10.66	10.92	11.18	11.45	4.8

Table Showing per cent. of Solids not Fat Corresponding to per cent. of Fat and Quevenne Lactometer Reading.

Per cent. of Fat.	Lactometer Reading. 17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Per cent. of Fat.
4.9	5.42	5.69	5.95	6.21	6.47	6.74	7.00	7.26	7.53	7.79	8.05	8.31	8.58	8.84	9.10	9.37	9.63	9.89	10.15	10.42	10.68	10.94	11.20	11.47	4.9
5.0	5.44	5.71	5.97	6.23	6.49	6.76	7.02	7.28	7.55	7.81	8.07	8.33	8.60	8.86	9.12	9.39	9.65	9.91	10.17	10.44	10.70	10.96	11.23	11.49	5.0
5.1	5.46	5.73	5.99	6.25	6.52	6.78	7.04	7.30	7.57	7.83	8.09	8.36	8.62	8.88	9.15	9.41	9.67	9.93	10.20	10.46	10.72	10.99	11.25	11.51	5.1
5.2	5.48	5.75	6.01	6.27	6.54	6.80	7.06	7.33	7.59	7.85	8.11	8.38	8.64	8.90	9.17	9.43	9.69	9.96	10.22	10.48	10.74	11.01	11.27	11.53	5.2
5.3	5.51	5.77	6.03	6.29	6.56	6.82	7.08	7.35	7.61	7.87	8.14	8.40	8.66	8.92	9.19	9.45	9.71	9.98	10.24	10.50	10.77	11.03	11.29	11.55	5.3
5.4	5.53	5.79	6.05	6.31	6.58	6.84	7.10	7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47	9.74	10.00	10.26	10.52	10.79	11.05	11.31	11.58	5.4
5.5	5.55	5.81	6.07	6.34	6.60	6.86	7.13	7.39	7.65	7.92	8.18	8.44	8.70	8.97	9.23	9.49	9.76	10.02	10.28	10.55	10.81	11.07	11.34	11.60	5.5
5.6	5.57	5.83	6.09	6.36	6.62	6.88	7.15	7.41	7.67	7.94	8.20	8.46	8.73	8.99	9.25	9.52	9.78	10.04	10.31	10.57	10.83	11.10	11.36	11.62	5.6
5.7	5.59	5.85	6.11	6.38	6.64	6.90	7.17	7.43	7.69	7.96	8.22	8.48	8.75	9.01	9.27	9.54	9.80	10.06	10.33	10.59	10.85	11.12	11.38	11.64	5.7
5.8	5.61	5.87	6.13	6.40	6.66	6.92	7.19	7.45	7.72	7.98	8.24	8.50	8.77	9.03	9.30	9.56	9.82	10.09	10.35	10.61	10.87	11.14	11.40	11.67	5.8
5.9	5.63	5.89	6.16	6.42	6.68	6.95	7.21	7.47	7.74	8.00	8.26	8.53	8.79	9.05	9.32	9.58	9.84	10.11	10.37	10.63	10.89	11.16	11.42	11.69	5.9
6.0	5.65	5.91	6.18	6.44	6.70	6.97	7.23	7.49	7.76	8.02	8.28	8.55	8.81	9.07	9.34	9.60	9.86	10.13	10.39	10.65	10.91	11.18	11.45	11.71	6.0
6.1	5.67	5.93	6.20	6.46	6.72	6.99	7.25	7.51	7.78	8.04	8.30	8.57	8.83	9.09	9.36	9.62	9.88	10.15	10.41	10.67	10.93	11.20	11.47	11.73	6.1
6.2	5.69	5.95	6.22	6.48	6.74	7.01	7.27	7.53	7.80	8.06	8.32	8.59	8.85	9.11	9.38	9.64	9.90	10.17	10.43	10.70	10.96	11.23	11.49	11.75	6.2
6.3	5.71	5.97	6.24	6.50	6.76	7.03	7.29	7.55	7.82	8.08	8.35	8.61	8.87	9.14	9.40	9.66	9.93	10.19	10.45	10.72	10.98	11.25	11.51	11.77	6.3
6.4	5.73	5.99	6.26	6.52	6.78	7.05	7.31	7.57	7.84	8.10	8.37	8.63	8.89	9.16	9.42	9.69	9.95	10.22	10.48	10.74	11.00	11.27	11.53	11.80	6.4
6.5	5.75	6.01	6.28	6.54	6.80	7.07	7.33	7.59	7.86	8.12	8.39	8.65	8.91	9.18	9.44	9.71	9.97	10.24	19.50	10.76	11.03	11.29	11.55	11.82	6.5
6.6	5.77	6.03	6.30	6.56	6.83	7.09	7.35	7.62	7.88	8.14	8.41	8.67	8.94	9.20	9.47	9.73	9.99	10.26	10.52	10.78	11.05	11.31	11.58	11.84	6.6
6.7	5.79	6.05	6.32	6.58	6.85	7.11	7.37	7.64	7.90	8.17	8.43	8.69	8.96	9.22	9.49	9.75	10.01	10.28	10.54	10.81	11.07	11.33	11.60	11.86	6.7
6.8	5.81	6.08	6.34	6.60	6.87	7.13	7.40	7.66	7.92	8.19	8.45	8.71	8.98	9.24	9.51	9.77	10.03	10.30	10.56	10.83	11.09	11.36	11.62	11.89	6.8
6.9	5.84	6.10	6.36	6.62	6.89	7.15	7.42	7.68	7.94	8.21	8.47	8.73	9.00	9.26	9.53	9.79	10.06	10.32	10.59	10.85	11.12	11.38	11.65	11.91	6.9
7.0	5.86	6.12	6.38	6.64	6.91	7.17	7.44	7.70	7.96	8.23	8.49	8.76	9.02	9.29	9.55	9.81	10.08	10.34	10.61	10.87	11.14	11.40	11.67	11.93	7.0
7.1	5.88	6.14	6.40	6.67	6.93	7.19	7.46	7.72	7.99	8.25	8.51	8.78	9.04	9.31	9.57	9.83	10.10	10.36	10.63	10.89	11.16	11.42	11.69	11.95	7.1
7.2	5.90	6.16	6.42	6.69	6.95	7.21	7.48	7.74	8.01	8.27	8.53	8.80	9.06	9.33	9.59	9.86	10.12	10.39	10.65	10.92	11.18	11.45	11.71	11.97	7.2

Table Showing per cent. of Solids not Fat Corresponding to per cent. of Fat and Quevenne Lactometer Reading.

Per cent. of Fat.	Lactometer Reading.																								Per cent. of Fat.
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
7.3	5.92	6.18	6.44	6.71	6.97	7.24	7.50	7.76	8.03	9.29	.56	8.82	9.09	9.35	9.61	6.88	10.15	10.41	10.67	10.94	11.20	11.47	11.73	11.99	7.3
7.4	5.94	6.20	6.46	6.73	6.99	7.26	7.52	7.79	8.05	8.32	8.58	8.84	9.11	9.37	9.64	9.90	10.17	10.43	10.69	10.96	11.22	11.49	11.75	12.02	7.4
7.5	5.96	6.22	6.48	6.75	7.01	7.28	7.54	7.81	8.07	8.34	8.60	8.86	9.13	9.39	9.66	9.92	10.19	10.45	10.72	10.98	11.25	11.51	11.78	12.04	7.5
7.6	5.98	6.24	6.51	6.77	7.03	7.30	7.56	7.83	8.09	8.36	8.62	8.88	9.15	9.42	9.68	9.95	10.21	10.47	10.74	11.00	11.27	11.53	11.80	11.06	7.6
7.7	6.00	6.26	6.53	6.79	7.06	7.32	7.58	7.85	8.11	8.38	8.64	8.90	8.17	9.44	9.70	9.97	10.23	10.50	10.76	11.02	11.29	11.56	11.83	12.09	7.7
7.8	6.02	6.28	6.55	6.81	7.08	7.34	7.61	7.87	8.14	8.40	8.66	8.93	9.19	9.46	9.72	9.99	10.25	10.52	10.78	11.05	11.31	11.58	11.85	12.11	7.8
7.9	6.04	6.30	6.57	6.83	7.10	7.36	7.63	7.89	8.16	8.42	8.69	8.95	9.21	9.48	9.74	10.01	10.28	20.54	18.81	11.07	11.33	11.60	11.87	12.13	7.9
8.0	6.06	6.32	6.59	6.85	7.12	7.38	7.65	7.91	8.18	8.44	8.71	8.97	9.24	9.50	9.77	10.03	10.30	10.56	10.83	11.09	11.36	11.62	11.89	12.15	8.0
8.1	6.08	6.35	6.61	6.87	7.14	7.40	7.67	7.93	8.20	8.46	8.73	8.99	9.26	9.52	9.79	10.05	10.32	10.58	10.85	11.11	11.38	11.64	11.91	12.18	8.1
8.2	6.10	6.37	6.63	6.90	7.16	7.43	7.69	7.96	8.22	8.48	8.75	9.01	9.28	9.54	9.81	10.07	20.34	10.60	10.87	11.13	11.40	11.66	11.93	12.20	8.2
8.3	6.12	6.39	6.65	6.92	7.18	7.45	7.71	7.98	8.24	8.50	8.77	9.04	9.30	9.57	9.83	10.10	10.36	10.63	10.89	11.16	11.42	11.68	11.95	12.22	8.3
8.4	6.14	6.41	6.67	6.94	7.20	7.47	7.73	8.00	8.26	8.53	8.79	9.06	9.32	9.59	9.85	10.12	10.38	10.65	10.91	11.18	11.45	11.71	11.98	12.24	8.4
8.5	6.16	6.43	6.69	6.96	7.22	7.49	7.75	8.02	8.28	8.55	8.81	9.08	9.34	9.61	9.88	10.14	10.41	10.67	10.94	11.20	11.47	11.73	12.00	12.26	8.5
8.6	6.19	6.45	6.72	6.98	7.25	7.51	7.78	8.04	8.31	8.57	8.84	9.10	9.37	9.63	9.90	10.16	10.43	10.69	10.96	11.22	11.49	11.76	12.02	12.29	8.6
8.7	6.21	6.47	6.74	7.00	7.27	7.53	7.80	8.06	8.33	8.59	8.86	9.12	9.39	9.65	9.92	10.18	10.45	10.72	10.98	11.24	11.53	11.78	12.04	12.31	8.7
8.8	6.23	6.49	6.76	7.02	7.29	7.55	7.82	8.08	8.35	8.61	8.88	9.14	9.41	9.67	9.94	10.21	10.47	10.74	11.00	11.27	11.51	11.80	12.06	12.33	8.8
8.9	6.25	6.51	6.78	7.04	7.31	7.57	7.84	8.10	8.37	8.63	8.90	9.16	9.43	9.69	9.96	10.23	10.49	10.76	11.02	11.29	11.55	11.82	12.09	12.35	8.9
9.0	6.27	6.53	6.80	7.06	7.33	7.59	7.86	8.12	8.39	8.65	8.92	7.18	9.45	9.72	9.98	10.25	10.51	10.78	11.05	11.31	11.57	11.84	12.11	12.38	9.0
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	

"This formula expressed in words gives the following rule for the calculation of solids not fat and of total solids, when the Quevenne lactometer reading and per cent. of fat are known:

"Add the Quevenne lactometer reading at 60° F to seven-tenths of the per cent. of fat and divide the sum by 3 8. The result will be the solids not fat, and this added to the per cent of fat gives the per cent. of total solids.

"The relations which exist in normal milks, between the factors which enter into the last formula are such that the accuracy of the formula is but slightly affected by changing to the following:

$$\text{Solids not fat} = \frac{L + f}{4}$$

"This simple expression gives results with average herd milks which do not vary more than .1 from those obtained by the general formula given above and is consequently well adapted for use in factories in making preliminary examinations for adulterations.

"In general it may be stated that no milk is pure when the Quevenne lactometer reading added to the per cent. of fat does not exceed 32.

"The amount of water which has been added to a known sample of milk may be calculated from the solids not fat by dividing the per cent of solids not fat in the suspected milk by the per cent. of solids not fat in the original sample and multiplying the product by 100. The result will be the number of pounds of milk in 100 pounds of the milk examined. The difference between this and 100 will be the water added. *Example:* The solids not fat in a sample of milk equals 9 per cent. and after water had been added to the milk the solids not fat were only 7 per cent. Then $\frac{7}{9} \times 100 = 77.7$ per cent. of milk in the watered sample and $100 - 77.7 = 22.3$ per cent. of water. That is 22.3 pounds of water had been added to 77.7 pounds of milk When the solids not fat in the original milk are not known the legal standard may be taken for this calculation. In states where no legal standard is established, it may generally be assumed that milk containing less than 8 5 per cent. of solids not fat is watered. In all cases, however, when practicable, a sample of milk should be obtained at the farm and compared with the suspected sample.

III. BUYING AND SELLING COWS BY TESTS OF THEIR MILK.

We propose a method by which cows may be bought or sold on individual merit, and recommend it to farmers and dairymen for trial. It will, if used, change some estimates of the value of cows, and may prevent some sales, but if a cow cannot be purchased by this rule, the chances are few in this section that the buyer would be benefited by owning the animal. To offer to sell upon this basis, something on many cows might be lost to the seller, but a really good cow would bring nearer her true value than by the usual mode of selling, and often more than could otherwise be obtained. The rule can be stated as follows:

Value of cow in dollars=(Daily yield of milk in pounds $\div 8\frac{3}{5}$)* $\times$ 12 + 4 (Per cent. of fat — 3.50.)

To buy or sell by this plan give or receive twelve dollars ($12) per gallon of milk yielded per day that is rich enough to show 3.50 per cent fat. To this price per gallon add or substract one dollar for every one-fourth of one per cent. of fat above or below 3.50 per cent.

Comparative Value of Cows for Milk or Beef, Calculated by the North Carolina Station Rule.

Name and Breed of Cow.	Dairy Value, calculated at beginning of lactation.	Dairy Value, calculated on average production of milk.	Beef Value, calculated on average weight for the year at 8 cents per pound.
Dora, Jersey	$ 22.59	$ 21.53	$ 25.38
No. 2, Grade Jersey	32.97	20.80	25.11
No. 3, Grade Jersey	28.11	-----	31.86
No. 5, Native	30.06	31.23	24.96
No. 7, Native	29.57	21.83	26.46
Jersey Guernsey, Cross-bred	48.22	36.70	25.59
Spot, Grade Jersey	27.72	26.93	24.27
Miss Haley, Native	24.84	17.21	22.56
Miss Jones, Native	23.73	22.18	20.49
Devon, Registered	-----	17.17	28.20
C. C.'s Durham (Mountain Cow)	-- --	23.90	22.20
No. 14, Jersey	40.36	34.90	25.77
No. 15, Grade Jersey	-----	20.48	22.68
Daisy E., (Mountain Cow)	39.70	-----	26.79

* To reduce to gallons.

The values of a number of cows have been calculated, which have been tested by weight of milk and per cent. of fat in same. The foregoing table shows in the first column the names and breed of cows, the second column the value according to yield of milk and its richness in fat when they were in full lactation during 1893, and the third column gives the same test for a year or the longest time the cow was under observation less than a year. The last column "beef value" is based on the average, taken at the end of each calendar month. Three weights are taken on three mornings in succession before feeding or watering. These have been averaged, for the time each cow's record was used, for the third column, and the average weight reckoned at a valuation of three cents per pound. Of course the cow must be nearly fat to be worth this sum.

IV. THE PRACTICAL VALUE OF MILK TESTING,

AS SHOWN BY COMPARING THE YIELD OF TWO YOUNG COWS.

These cows were purchased in the winter and summer before coming in with their first calves. "Spot," a Grade Jersey, was bred by Mr. T. A. Lambeth, Lockville, N. C., and was brought to the Experiment Farm in February, 1892. She dropped her first calf October 2d, following. "Miss Haley" was brought to the farm by Mr. W. W. Haley in 1892. She had a bad character as a fence breaker, but had been kept, hoping she would prove to be as good a cow as her dam. She exhausted Mr. H.'s patience by her mischievousness, and was sold to the farm as likely otherwise to prove a good cow, as her mother was reputed to be a fine milker. Miss Haley dropped her first calf in September, 1892. Both heifers were probably just past three years old when they came into milk for the first time. Their milk has been weighed at every milking, and since October, 1892, the milk has been tested for fat at both milkings of one day for each month. This comparison includes one year for Miss Haley, beginning October 1st, 1892, and ending September 30th, 1893; and one year and a half day for Spot, the exact time she gave milk which was used. Both cows were bred to come in fresh again in the fall of 1893. Spot dropped a calf on November 29th, 1893, having been dry from October 4th; 56 days. Miss Haley, although carefully looked after, is a shy breeder. She failed to come in during April, 1894, when she was expected. She has since been disposed of to the butcher.

The appearance of both cows is shown in the half-tone reproduction (Fig. 6) from a photograph, on page 134.

The milk yield of these cows for the year was for Spot, 5078.15 pounds; for Miss Haley, 3961.99 pounds.* Spot has yielded 28.17 per cent. more milk than has Miss Haley. The feed of these cows will be discussed separately. In the main it has been alike, and as much as each would consume.

The milk from these cows has been added to the mixed herd milk and run through the separator. But from the monthly tests has been obtained a means of comparison of the butter yielding capacity of the two cows.

From the weight of milk and per cent. of fat contained on the days tested, the pounds of fat for each month has been calculated by multiplying the amount of fat for one day by the number of days in the month. This gave 251.661 pounds of butter fat yielded by Spot, and 192.058 pounds for Miss Haley. Some analyses of our

* The above yields expressed in gallons would be 586.4 and 457.5 gallons respectively, allowing 8⅔ pounds per gallon. This is equivalent to a daily yield of 1.606 gallons, or a little under 14 pounds per day for Spot, and 1.25 gallons, or about 11 pounds for Miss Haley per day for the whole year.

FIG. 6.—TWO YOUNG COWS, "MISS HALEY" and "SPOT."

Illustrating differences in yield of two cows of the Station Herd. Yearly yield of Miss Haley was 226 lbs., of Spot 296 lbs., which is 31 per cent. larger yield in favor of Spot. Such differences might easily occur unnoticed in other herds, if not carefully examined.

butter gave nearly 15 per cent. of water, salt, etc., hence we have calculated on its average contents of 85 per cent. of solid butter fat. These figures would give as the yearly yield of butter from these two cows, 296. pounds from Spot, and 226. pounds from Miss Haley. This shows a yield of 70. pounds more from Spot than from Miss Haley. This is 31 per cent. more butter from the milk of one cow than from the other. A detailed statement of milk and butter yield by months for each cow can be seen by referring to the table. The same care and nearly the same feed has been given these cows.

Table showing the Comparative Yield of Milk and Butter from Two Cows, by Months.

	Spot.					Miss Haley.				
	Pounds of fat in one day's milk	Days m'lk'd each m'nth.	Pounds fat in each month.	Pounds of butter each month at 85 per cent. fat.	Total yield of milk in pounds	Pounds of fat in one day's milk.	Days m'lk'd each m'nth.	Pounds fat in each month.	Pounds of butter each month at 85 per cent fat.	Total yield of milk in pounds.
October	.843	28	23.604	27.77	382.25	.652	31	20.212	23.78	436.94
November	.631	30	18 930	22.27	496 62	.550	30	16.500	19.41	416.06
December	.7565	3	23 450	27.59	528.25	633	31	19 623	23 09	429.69
January	.8424	31	26.110	30.72	474.23	.5478	31	16.982	19.98	298.55
February	6333	28	17.730	20.86	390.25	.497	28	13 916	16 37	288.40
March	.6963	31	21 585	25 39	424.70	.513	31	15.903	18.71	319 45
April	.7136	30	21.408	25.18	480.50	.5548	30	16.644	19.58	342.05
May	.8588	31	26.623	31.32	499.10	.584	31	18.104	21.30	331.65
June	.7200	30	21.600	25.41	458.90	.517	30	15 510	18.25	298.20
July	.717	31	22.227	26.15	466 55	.466	31	14 446	17.00	305.80
August	.5911	31	18 324	21.56	328.6[illegible]	.410	31	12.710	14.95	271.70
September	.317	30	9.510	11 19	138.75	.3836	30	11.508	13.58	223.50
October	.140	4	.560	00.66	9.40	------	--	-------	-------	--------
			251 661	296.07	5078.15			192 058	225.96	3961.99

Other trials my be cited in this line of comparison by giving the record of two unregistered Jersey cows tested at the New York State Experiment Station in 1890. Several trials were made by feeding the cows fresh in milk as near alike as possible, with the following results: The cows were named May and Belle. These tests were for seven milkings each.

1st. May gave 55.4 per cent. more milk which made 44.8 per cent. more butter than Belle's milk with a little less food.

2d. May gave 65.48 per cent. more milk which made 71.87 per cent. more butter than Belle's milk with more food

3d. May gave 73.96 per cent. more milk which made 66.67 per cent. more butter than Belle's milk with more food.

4th. May gave 71.15 per cent. more milk which made 84.00 per cent. more butter than Belle's milk with more food.

5th. May gave 66.41 per cent. more milk which made 74.51 per cent. more butter than Belle's milk with less food.

The difference in food amounted to 1.45 pounds of dry matter in the first trial for 1,000 pounds live weight, 1.50 pounds of dry matter in the second, 3.24 pounds for third trial, 2.24 pounds for the fourth and 1.47 pounds of dry matter in the fifth trial.

These were young cows milking with first calves. They had been reared together and fared nearly alike all their lives. Both were well grown and fine specimens of Jersey cows. Both were full Jersey but unregistered.

During the first trial, a mature Jersey cow fresh in milk was compared with these heifers. Nellie, the older cow, gave less milk and butter than did May, but more than Belle; thus May gave 16.97 per cent. more milk than Nellie which made 40.31 per cent. more butter than did Nellie's milk. But May also ate 3.7 per cent. more hay than did Nellie, but this is small compared with the increased yield.

In the fifth period, a black grade Holstein-Friesian heifer "Star" just beginning lactation for the first time, was compared with May and Belle. Star gave more milk and made less butter according to the following ratios: She gave 58.29 per cent. more milk, but May's yield of butter was greatest by 40.2 per cent. Star's yield of butter was 24.46 per cent greater than that of Belle.

Reports of such comparative tests might be further extended. They show that the widest differences may and do exist between fine specimens of any one breed. This is further shown in the most notable trials ever made, those at the World's Fair at Chicago. In that test the breeders of dairy cattle were particularly interested, and made great efforts to secure favorable results as well as in obtaining the best cows that could be found in each breed represented.

It appears therefore that the tests reported above are not isolated cases. Every dairy farmer, and every cow owner, is probably feeding cows which vary quite as much if not more than those we have tested and show in the records above. It is probable that on nearly every farm the profits of some one or more cows is being used to pay for the support of others which do not pay for their food.

How to find out the best, and thus profit by the knowledge, should be the aim of every progressive dairyman. It is easily done and requires only care and accuracy for any farmer to know which animals yields him a net income and from which he should raise breeding stock.

The milk from each cow should be measured or weighed. It is easier and more accurate to weigh and record in such a way that the yield from each cow can be obtained separately.

Probably the best method of weighing milk is to make all milking pails of the same weight by addition of solder to the bottom of the lighter pails. Then weigh on a double beam scale, or on a spring balance having two pointers, one of which can be set for the weight of the pail.

The Chatillon Spring Balances are reliable. One graduated in the decimal scale to weigh by tenths (.10) and five hundredths (.05) of a pound is sold by Messrs. Borden & Selleck, Chicago, Illinois.

FIG. 7.—Chatillon Spring Balance.

Knowing the weight of the milk, its quality must be determined also, as this is a necessary factor in estimating the value of milk, as has already been described. For instance, one cow might be found with a daily yield of 30, another 20, and a third 15 pounds of milk. If judgment were based on yield alone, it is evident which would be called the best and most valuable cow. But if the milk of the first yields but $2\frac{1}{2}$ per cent. fat, while the milk of the second and third yields 4 and 6 per cent. respectively, the yields would be .75, .80, and .90 pounds of fat per day. The real relative values of the cows would be therefore reversed, or would depend on the cost of food consumed and relative amount of fat in the milk which could be recovered in the butter, as well as upon the length of time each cow could remain in milking. Therefore a one-day test cannot be trusted, but must be repeated once a week or month; or a composite should be taken from the milk of each cow for several days in succession, and an average assumed for each cow from the analysis of the composite sample.

If farmers would wish to utilize the Babcock Test, yet do not like themselves to spend the time to learn and apply the details, it would be well to combine and encourage some young man or woman to become proficient in operating to make the tests at a given amount each. Say 5 cents for each determination in duplicate, and 5 cents additional for calculation and recording the same, where a whole herd would be tested. This would cost but $1.20 per year for each cow, which is a low price for the information it would give as to the value of a herd.

This practiced would result in turning over many worthless cows to the butchers, and in raising cow calves only from those which were found on trial to be profitable individuals themselves.

Tests of Dairy Implements and Practices

I. THE BERRIGAN SEPARATOR.
II. THE HORIZONTAL DE LAVAL SEPARATOR.
III. THE COOLEY CREAMER.
IV. THE ORDINARY MILK-SETTING SYSTEM.
V. THE U. S. HAND SEPARATOR.
VI. THE VICTORIA HAND SEPARATOR.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

BULLETIN NO. 114

JUNE 20, 1895.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

STATION COUNCIL.

OFFICERS OF THE EXPERIMENT STATION.

RALEIGH, N. C.

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The complete bulletin embraces 32 pages. It will be sent free on application to parties inside North Carolina; to others, on receipt of four cents in postage. Apply to Dr. H. B. BATTLE, Director, Raleigh, N. C.

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TESTS OF DAIRY IMPLEMENTS AND PRACTICES.

I. THE BERRIGAN SEPARATOR.
II. THE HORIZONTAL DE LAVAL SEPARATOR.
III. THE COOLEY CREAMER.
IV. THE ORDINARY MILK-SETTING SYSTEM.
V. THE U. S. HAND SEPARATOR.
VI. THE VICTORIA HAND SEPARATOR.

BY F. E. EMERY, AGRICULTURIST.

COMPARISONS WITH THE BERRIGAN SEPARATOR, THE HORIZONTAL DE LAVAL SEPARATOR, THE COOLEY CREAMER, AND THE ORDINARY MILK-SETTING SYSTEM IN WATER AND IN AIR.

In our mild climate, where either artificial ice, or none at all, must be used by dairymen, it is essential that some rapid process of separating the milk be found which can be furnished at a moderate cost.

It is hoped that this Station will be able to give a fair trial to the most promising methods and apparatus for obtaining good results, and help bring into general use those methods and implements by which the value of the products of the dairy is increased or labor is diminished. By the common methods of creaming milk, we believe there are considerable losses, which can be avoided by using separators of moderate cost.

When the Berrigan Separator was put on the market, in 1892, the price being much lower than any other we knew of, it seemed desirable to give it a trial, and the manufacturers kindly consented to send a machine here for that purpose.

On the trial days, the morning's milk was divided, in order to compare deep setting of the milk in well-water, and in air, with the Berrigan Separator. The evening's milk was run through a Horizontal De Laval Separator, thus affording a fair comparison with that machine with mixed milk from the same cows, although drawn at a different milking.

The first comparisons ended with the fat test of milk drawn at intervals from the bottoms of the cans. This, of course, gave the lowest possible percentage of fat in skim milk, and much less than would have been found in an average sample of all the skim milk in either can during any of the times it was drawn.

In every case the Berrigan Separator was handled as nearly according to directions as possible. We failed to raise the pressure as high

as directed until the air-pump had been renewed, and then it required sharp work to secure 30 pounds pressure in one-half to three-fourths of one minute. The more rapid separation, on April 8th and 9th, was due to the influence of a cool wave, during which the temperature ranged down to 50.° F., and our dairy room was given the benefit of the change; hence, this period was more favorable to the Berrigan machine.

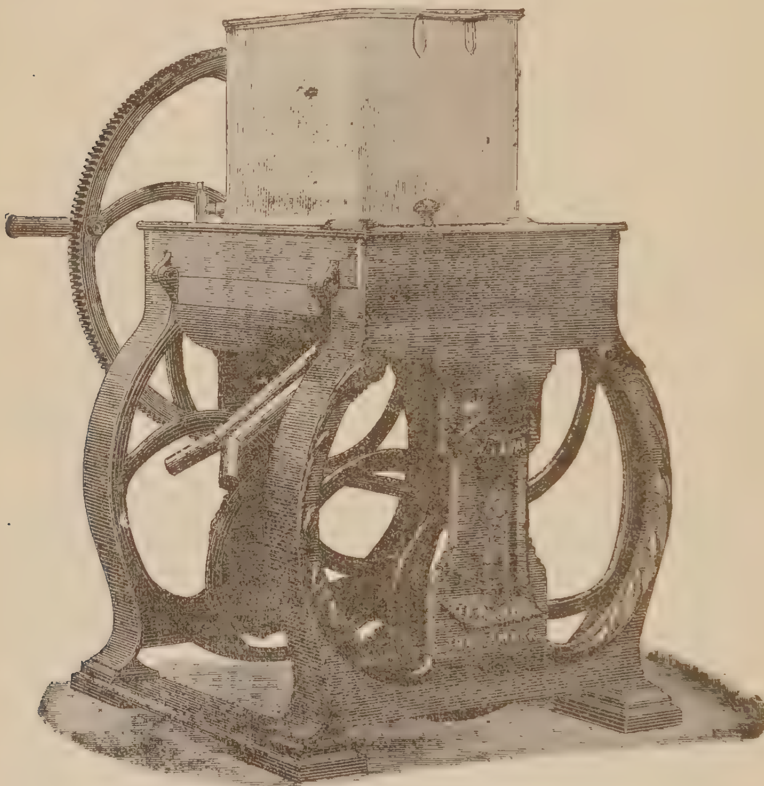

FIG. 1.—Horizontal DeLaval Separator—Hand or Power.

All the percentages of fat in skim milk for any given number of hours, were obtained by drawing out a few ounces of milk from the bottom of the cans, with the least possible disturbance, and testing this small amount, which was the best separated portion in the cans. These percentages, therefore, cannot be used to calculate for total losses. They are only comparable with each other, and seem to show, as far as the test was conducted, that the Berrigan does not save as much as was claimed. Indeed, from the results of the trial, this machine was not efficient as the common plan of deep-setting in both air and water, and was much less efficient than the Horizontal De Laval Separator.

TABLE I.—First Comparison of Different Methods of Creaming Milk.

	BERRIGAN SEPARATOR. CAN SET IN AIR AT TEMP. OF DAIRY.				CAN SET IN AIR AT TEMPERATURE OF DAIRY.				CAN SET IN WELL WATER AT 60° FAHRENHEIT.				HORIZONTAL DELAVAL SEPARATOR.			
	Ap'l. 6	Ap'l. 7	Ap'l. 8	Ap'l. 9	Ap'l 6	Ap'l. 7	Ap'l. 8	Ap'l. 9	Ap'l 6	Ap'l. 7	Ap'l. 8	Ap'l. 9	Ap'l 6	Ap'l. 7	Ap'l. 8	Ap'l. 9
	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	A. M.	P. M.	P. M.	P. M.	P. M.
Pounds of milk used	17.	15.	16.	15.	17	15	14.75	15.	17	15	16.	15	44.44	42.44	37.44	44.06
Temperature of milk in degrees Fahrenheit	90.	93	lost.	lost.	s'me	as in	Berr	igan	s'me	as in	Berr	igan	92.	92.	90.	88.
Pounds water added	2	2	4	4												
Pounds pressure applied	24	23	22	22												
Time required to pump up pressure (minutes)		1	1	1												
Pressure maintained (minutes)	2	2	2	2												
Per cent. of fat in milk used	60.75	4.95	4.80	4.50	s'me	as in	Berr	igan	s'me	as in	Berr	igan		5.80	6.15	6.60
Per cent. of fat in skim-milk after 1½ hours	3.50				2.20				1.30							
Per cent. of fat in skim milk after 2 hours		2.40	1.80	1.60		1.40	1.40	1.20		1.00	1.00	0.80				
Per cent. of fat in skim-milk after 5 hours		1.20	1.00	1.00	0.60	0.60	0.60	0.40		0.60	0.60	0.60				
Per cent. of fat in skim-milk after 9 hours		0.60	0.40	0.40		0.40		0.40		0.30		0.40				
Per cent. of fat in skim-milk after 11 hours				0.40					a0.40							
Per cent. of fat in total skim-milk	1.00				0.40		1.00		0.40		1.22		0.30	0.05	0.10	0.075

a. 3 hours of the time in air. b. 5 hours in water and 4½ in air.

The Ordinary Milk-setting System.—The cans set in air were Cooley half cans (see Fig. 2), in which there was more cooling surface than in the broader Berrigan can, which may account for some difference in favor of the air setting. The cans set in well water were also Cooley half cans, but not submerged. They were set as is usual in deep setting in spring water for surface skimming, but were skimmed by drawing the skim-milk out at the bottom.

Better results were obtained from this system than by the Berrigan plan, and about equal to setting in air aided by the unusually cool temperature which prevailed at that time.

The Horizontal DeLaval Separator*, (see Fig. 1), had been in use nearly a year when these trials were made. The usual care only was given, except in one instance (that on the 6th), less separated milk than usual was run through at the end, and some cream was not forced out of the bowl, but was left to mix with the skim-milk and gave to it a higher per cent. of fat than usual. All samples of separated milk were taken from a mixture of the whole lot, poured from one vessel to the other sufficient to insure its being homogeneous.

Each 100 pounds of milk run into this separator yielded 81.60 pounds of centrifugal skim-milk (containing 1.77 per cent. of the fat in the original milk), and 16.45 pounds of cream, as is seen from the following table. There was a loss from wetting the separator, pails, etc., of 1.95 per cent. This ratio is insignificant when large quantities of milk are handled.

	Whole Milk. Lbs.	Fat in Whole Milk. Lbs.	Skim Milk. Lbs.	Fat Contained in Skim-Milk. Lbs.
1st trial	44.4375	2.6997	36.125	.10837
2d trial	42.4375	2.4614	34.625	.01731
3d trial	37.4375	2.3044	31.000	.03100
4th trial	44.0625	2.908	35.625	.02672
	168.375	10.3735	137.375	.18340

The Berrigan Separator.—The following circular and directions for operating the Berrigan Separator was received with the machine. The separation consisted in putting the milk under pressure of about three atmospheres for a few minutes, and in dilution of one-eighth to one-fourth its volume of water. This machine was not long on the market, and has since been withdrawn.

The Berrigan Separator.

Is the most remarkable improvement in the art of cream raising and butter making yet discovered, for the following reasons:

1. It is simple of construction, has no parts liable to wear out easily, and should last for years without repair, under ordinary use.
2. It requires no skilled labor to operate it, and can be operated by a child.
3. It can be used in any climate. No ice, heat, or artificial temperature required, and no water for setting.
4. No oil, belting, pulleys, shafting, engine or other appliances are needed excepting those furnished by us.

*This form of DeLaval Separator is no longer on the market.

5. It is by far the cheapest Separator for its capacity ever made.
6. The cream is not whipped or injured as in centrifugal machines, and is ready for delivery from 12 to 24 hours ahead of all deep setting methods.
7. Cream raised by this method is more easily kept sweet, and for a much longer period than by any other method.
8. Less labor is required by this method than by any other, and an equal percentage of cream is obtained.
9. By heating the cream to 58° or 60° Fahrenheit, and treating it the same as the milk, (but without water,) running it into the churn from the Separator, *whether sweet or otherwise*, the butter will come in a shorter time and less fat will be left in the buttermilk, than by any other process. No other Separator possesses these advantages.

DIRECTIONS.

1. Always keep the separator sweet, clean and dry when not in use. Do not allow any milk to remain or sour in it.

Cleanse it thoroughly, so as to leave no dirt or grease on the surface of the metal inside, and dry it thoroughly immediately after using. The best way to do this is to wash first with lukewarm water, using a scrubbing brush, then rinse with scalding water. Wipe dry and leave the cock at the bottom and the handhole both open so as to have free ventilation through the machine. It is well occasionally to put a little pressure on with the pump when there is water in the machine, and open the cock below, when the water will be driven out of the cock with force, and cleanse it more thoroughly.

2. After removing the handhole plate, and closing the cocks (11) and (16), put into the Separator before putting in the milk, one pint of clean water, at any temperature, for each gallon of milk to be treated, and if very quick results are desired, put in one quart of water for each gallon of milk to be treated; then insert the strainer into the handhole and strain the milk through it into the Separator, taking care not to fill the Separator nearer than one inch of the top. Adjust the handhole plate so as to close it air tight, and pump up quickly about 30 pounds of pressure. Let the milk remain under this pressure two or three minutes, then open the pet cock (11) and let pressure off at once.

3. Open the cock (16) in the bottom of the Separator and run the milk into the vat, and set until the cream is up. This can be seen through the observation glass in the vat.

4. Draw off the milk from under the cream, through the faucet in the vat, to within one inch of the cream line, thus leaving the cream in the vat ready for use.

5. When the milk is let off from the Separator into the vat, the Separator is ready for another charge. Repeat the operation until all the milk is treated. Each operation requires five minutes or less.

6. The best and quickest results will be secured when the milk to be treated is rich in cream, from a new milch cow, and treated while the milk is warm, immediately after milking. In such a case the cream will probably be up in one hour.

The poorest result will be found when the cow has been long in milk, when the milk is poor in cream and has stood for some time and become chilled. In such cases two hours may be required to raise the cream.

If the milk is allowed to stand in the raising vat about seven hours, the fat will rise to within 2-5 of 1 per cent., and if allowed to stand 24 hours, the fat will practically all rise. Much closer results will be obtained right along in practice than by any other known system.

DESCRIPTION OF PARTS.

1 Handle to Handhole Plate.
2 Handhole Plate.
3 Handhole Gasket.
4 Gauge.
5 Outside Handhole Plate.
6 Top of Separator.
7 Body of Separator.
8 Section of Pump Handle.
9 Second Section of Pump Handle.
10 Leg.
11 Pet Cock at bottom of air pipe.
12 Check Valves.
13 Piston Rod of Pump.
14 Eye piece in Handhole Plate.
15 Bottom of Separator.
16 Large Cock at bottom of Separator.
17 Pins for Pump Handle.
18 Pump.
19 Screw to hold pump to bottom.
20 Piston of Pump.
21 Strainer.
22 Milk Vat.

Nos. 1, 2, 3, 5 and 14, constituting the Handhole Plate complete, always remain together, and are taken out and put in as one piece.

Any of the parts of the Separator, including the vat and strainer, may be ordered by giving the number of the part as shown in the foregoing cut, and the size of the Separator it is designed for. One Vat and one Strainer go with each Separator and are included in the price. Additional vats will be furnished on special order.

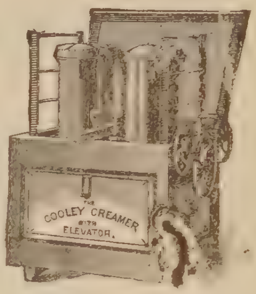

Fig. 2.—Cooley Creamer.

Later in the season, when the weather became warmer, other trials were made. The Berrigan Company had changed the air-pump, and it was possible to secure the required pressure quite rapidly. The second trial is included in Table III. (see p. 139), compared with setting by the Cooley Creamer process (see Fig. 2), submerged in cold water, and again with the Horizontal De Laval Separator. For this test, the Horizontal Separator was run two mornings and two evenings on four successive days, and the milk from the same herd of cows for the other four milkings was mixed and divided for testing the Berrigan Separator and Cooley Creamers.

Temperature of the Dairy.—The dairy was built, in 1889, for the purpose of securing a steady and low temperature by preventing entrance of warm air from without. The cut in Bulletin No. 68, p. 103, shows how the warm air is kept out by air spaces, formed by paper nailed to the studding between the siding and inside matched boarding. Double doors and windows assist in holding this low temperature. The temperature of the dairy room was taken five times during each day after the 26th, while that of the Cooley Creamer three times per day. The temperature of the room was lower at night from opening the window, and therefore the temperature at which the Berrigan-treated milk was set averaged lower than the mean given in Table II. This milk, therefore, had an advantage of lower temperature of the cooling medium during this trial.

TABLE II.—A Comparison of the Dairy and of the Cooley Creamer in Degrees Fahrenheit.

Temperature of Dairy.							Temperature of Cooley Creamer.			
Date. April, 1892.	7 a. m.	9 a. m.	11 a. m.	3 p. m.	7 p. m.	Mean Temperature.	7 a. m.	12 m.	7 p. m.	Mean Temp.
26th	56.	......	......	....	......	....	60.	62.	60.	60.7
27th	50.	56.	59.	60	62.	57.4	58.	58.	58.	58.
28th	52.	......	61.	{ 60 1 p.m. } { 62 4 p.m. }	64.	59.8	58.	58.	58.	58.
29th	60.	62.	63.	{ 62 1 p.m. } { 60 4 p.m. }	60	61.1	62.	54.*	46.	......

*Temperature 9.30 a. m. 65°, at which time ice was put into the creamer and the water cooled to 54° at 12, 50° at 1 p. m., 46° at 4 p. m., and 46° at 6 p. m.

TABLE III.—Second Comparison of Different Methods of Creaming Milk.

	BERRIGAN SEPARATOR.				COOLEY CREAMER, SUBMERGED SYSTEM, IN WELL WATER AT 60. °F. ICE USED LAST DAY.				HORIZONTAL DE LAVAL CENTRIFUGAL SEPARATOR.			
	Date. April 26 A. M.	27 P. M.	28 P. M.	29 A. M.	April 26 A. M.	27 P. M.	28 P. M.	29 A. M	April 26 P. M.	27 A. M	28 A. M.	29 P. M.
Pounds of milk used	30.	26.	28.	28.0	30.0	26.0	28 0	28.0	52.875	60.00	56.00	50.50
Temperature of milk used in F.°	83.°	90.	90.	90.	88	90.	90.	......	90.	88.	88.	90.
Pounds of water added	4.	3.	3½	3½	......	3.	3½	......	......	......	......	......
Pounds of pressure applied	30.	30.	32.	32.	......	......	......	......	......	......	......	......
Time required to pump up pressure (seconds)	25.	45.	30.	30.	......	......	......	......	......	......	......	......
Time pressure kept up (minutes)	3.	3	3.	3.	......	......	......	......	......	......	......	......
Per cent. of fat in milk used	5.20	5.60	5.80	5.00	5.20	5.60	5.80	5.00	6.00	4.80	5.00	5.10
Per cent. of fat in skim-milk after 2½ hours	......	......	......	1.60	......	......	......	1.00	......	......	......	......
Per cent. of fat in skim-milk after 5 hours	......	......	......	1.00	......	......	......	0.70	......	......	......	......
Per cent. of fat in skim-milk after 9 hours	0.80	......	......	0.40	0.20	......	......	0.05	......	......	......	......
Per cent. of fat in skim-milk after 12 hours	......	0.20	......	0.30	......	trace	......	trace	......	......	......	......
Per cent. of fat in skim-milk after 24 hours	0.20	......	......	......	trace	......	......	......	......	......	......	......
Per cent. of fat in total skim-milk	0.27c		0.60	0.30	0.55	0.20	0.80	trace	0.062	0.023	0 02	0.05
Pounds of skim-milk, total	26.875	23.25	25.44	24.56	24.31	23.31	25 75	20.94	44.38	43.75	46.75	42.06
Pounds of cream	6 06	6.25	6.5	4.81	5.00	5.00	6.13	5.81	8.56	9.44	8.75	7.88
Per cent. of fat in cream	23 00	......	......	25.00	26 00	28.00	27.00	25.00	35.00	30.00	32.00	32.00
Total fat in milk used	1.560	1.456	1.624	1.400	1.560	1.456	1.624	1.400	3.173	2.880	2.800	2.576
Fat in separated or skimmed milk	.071	......	0.153	.074	0.134	.047	.206	......	.028+	.010	.009	.021
Fat found in cream	1.409	......	......	1.203	1.300	1.400	1.655	1.452	2.996	2.832	2.800	2.522
Difference—less, + more than in original milk	—.08	......	......	—.123	—.126	—.009	+.237	+..?	—.149	—.038	+.009	—.033
Per cent. of total fat unaccounted for	5.13	......	......	8.79	8.08	0 62	......	......	4.69	1.32	......	1.28

The differences in skimming have much to do with the per cent. of fat left in the total skim-milk. The Berrigan-treated milk was better skimmed than the Cooley milk, but it was drawn out very close on the 28th instant, as indicated by the large amount of fat found in the skim-milk in Table III.

The Cooley skim-milk seems to have been drawn too close, or too fast, on the same date, and it was probably not drawn out on the 27th as close as on other days, except the 29th.

The fat in total skim-milk has been calculated in case of the Berrigan milk for the first day, by adding amounts in the small draughts made to that found at skimming; also for the Horizontal Separator when the last few pounds were collected separately and this tested separately from the bulk of the milk. These trials of testing the centrifugal skim-milk in two lots were made to check the amount of skim-milk run into the bowl at the end of separating in order to force all the cream out at the proper orifice.

These tests of separated or skim-milk were united and the fat calculated on the whole of the skim-milk for the first, second and third days.

The creams from these trials were churned separately on May 2d, with the following results:

TABLE IV.—Butter made from cream obtained by different methods of creaming milk.

	Berrigan Cream.	Cooley Cream.	Horizontal Separator Cream.
Weight of cream churned (lbs)	22.81	22.00	32.375
Temperature of cream degrees F	60.°	66.°	66.°
Temperature of room	69.°	68.°	72.°
Temperature of outside air	74.°	73.°	76.°
Temperature of granular butter	64.°	68.°	68.°
Weight of fresh butter (lbs)	7.31	6.44	12.69
Weight of salt used (ounces)	6.	6.	12.
Weight of salted butter (lbs)	7.69	6.75	12.94
Time churned (minutes)	40.	25.	45.
Total milk used for each churning	112.	112.	202.44
Pounds milk required for one of butter	14.56	16.59	15.64
Pounds of butter for 100 lbs. milk	6.86	6.03	6.39

The above result shows that the Berrigan treatment yielded 13.28 ounces of butter per 100 pounds of milk more than the Cooley process as handled, and 5.76 ounces more per 100 pounds of milk than the centrifugal separator. In our practice, however, the centrifugal process requires considerable less labor than the other methods.

Since the Berrigan machine is no longer on the market, it is needless to remark that some of the claims for it do not seem to be substantiated by these trials. The principal points noted are: (1) that the drawing of small amounts of milk from the bottom, show by the higher percentages of fat at equal times that the separation of fat was not taking place so fast as by the gravity processes; although the dilution, by giving the more watery appearance would lead to the supposition, if tests were not made, that the fat was being more

rapidly and thoroughly removed; the per cent. of fat in the total skim-milk of this and the following trials prove this, especially in the third trial, where correction has been made for the water added: (2), the claim that the cream will keep longer than by other gravity methods is doubtful, while there can be no doubt of the superiority of the keeping quality of cream from the centrifugal separators as compared with all other methods.

Different Methods of Creaming in Mid-Summer.

A third comparison of the different methods of creaming milk was made in the heat of mid-summer. The Berrigan machine was compared with setting in shallow pans, at the temperature of the dairy, and with deep setting in well water without ice and not often changed because of an insufficient water supply.

The morning milk was divided between these three plans, and the evening milk was run through the Horizontal DeLaval Separator, the record of which for the same days is included in Table V on page 143.

Temperatures in the Dairy.—The temperature which prevailed was more nearly that which private dairymen must experience from March to November, than those of the previous tests in April. The latter were rather low for April, while those in summer were not extreme, except for the deep setting in water, which should not have risen above 66° or 68° if set in spring water, or where a plentiful supply of well water would permit changing completely the cooling medium for each setting of milk. In our case, that could not be done. The double windows were opened at night when the temperature of the outside air was below that in the dairy, and closed in the morning when the air began to become warmer. In this way the dairy was kept aired and as cool as possible. The Cooley creamer was also left with cover raised when the external air was cooler than the water in it, and was kept closed at other times. With all the care which could be given, such as sprinkling the floor and keeping doors closed, the temperature was too high for good results in creaming milk by any of the means tried except the centrifugal separator.

TABLE VI.—Temperatures in the Dairy in degrees Fahrenheit.

Date.	Thermometer four feet high, Deg. F., away from any Draft.						Thermometer hanging at Window.						Cooley Creamer.			
	6 a.m.	8 a.m.	12 m.	5 p.m.	7 p.m.	Mean	6 a.m.	8 a.m.	12 m.	5 p.m	7 p.m	Mean	6 a.m.	12 m.	5 p.m	Mean
August 1	72	74	79	79	75	75.8	72	74	77	76	75	74.8	75	76	72	74.3
2	75	75	76	77	77	76.0	72	75	76	75	75	74.6	68	73	75	72.
3	76	75	76	75	79	76.2	71	71	74	75	74	73.0	72	68	68	69 3
4	75	74	79	81	80	77.8	71	72	75	80	80	75.6	67	70	70	69.0

During this trial the weights of all small samples drawn for tests at the different hours were not kept, and therefore the total skim-milk could not be determined with accuracy. In some of the skim-

ming, more milk was left in the cream than at other times, and not being able to make a just comparison of weights in this respect, no weights were recorded. Correction has been made for water added to the Berrigan-treated milk, and the figures, showing the per cent. and increased to represent only the milk used, appear in smaller type in the upper part of the spaces for per cent. The skim-milk for August 2d soured so that it was necessary to use 5 per cent. of ammonia to dissolve the curd before the tests could be made. Corrections are shown for this in the percentages obtained.

In comparing the skim-milk of the shallow pan setting with the others, a glass siphon was used to draw the sample from the bottom of the pan after the cream had first been carefully blown back from one edge and the siphon inserted to the bottom of the pan with the lower end closed, or air being lightly forced up through it. In this way only milk from the bottom could be drawn. In these tests, the percentages from the deep-setting show least fat, notwithstanding the high temperature, except on the 2d, when some cream was accidentally drawn down. The results with the deep-setting at different hours compare favorably with the other methods, except the centrifugal, which shows a better result.

By using the centrifugal separator and cooling only the cream, a comparatively large body of water to volume of the cream could be used for cooling, and fresh water used with each fresh yield of cream. This, without using other means than the water at hand, keeps the cream subjected to the lowest temperature possible. In practice, the cream pail containing the cream is set into a larger galvanized iron pail and fresh well water added until the inside pail is surrounded above the cream. At the next separation the fresh cream is run directly into the first,* the water previously used for cooling is now heated for wash water, and fresh well water put around the mixed and well-stirred cream. The usual plan is, that when enough cream has been collected for a churning, it is carefully stirred and placed where the temperature can rise or be reduced, if necessary, until it is ripe enough to churn. Generally this required from one morning to the next, but may vary considerably. The effect of the better practice just described with the centrifugal separator, and having only the cream to cool by means of well water at the ordinary temperature, is seen in the low percentages of fat left in the buttermilk, as shown in Table VII. The cream from the centrifugal separator was churned at a much lower temperature than were any of the other lots, and to this fact was doubtless due most of the difference, though there was far too large an amount of fat lost in this centrifugal cream.

In these lots (6 to 12 pounds) the amount of cream was too small to churn alone, therefore a known amount of buttermilk, from a previous churning in which the per cent. of fat was known, was added and the churning done, and after the fat was determined in the buttermilk as drawn from the churn, it was recalculated to show

*This practice has been changed to collecting the cream from the separator in a pail surrounded with cool well water and cooling it before adding to cream previously obtained.

TABLE V.—Comparison of Different Methods of Creaming Milk in Midsummer.

	Berrigan Separator.				Shallow Pan Setting.				Set Deep in Well-water.				Horizontal De Laval Separator.			
	Aug. 1	2	3	4	Aug. 1	2	3	4	Aug. 1	2	3	4	Aug 1	2	3	4 P. M.
Pounds of milk used	16.	14.	16.	16.	12.5	14.	15.	17.5	12.5	14.	16.	16.	42.00	34.63	45.0	41.38
Temperature of milk set, in F.°	89.	88.	91.	93.	87.	89.	91.	93.	87.	89.	91.	93.	95.	96.	97.	97.
Pounds of water added	2.	2.	4.	4.	----	----	----	----	----	----	----	----	----	----	----	----
Pressure applied by air-pump (pounds)	32.	32.	34.	32.	----	----	----	----	----	----	----	----	----	----	----	----
Time required to raise pressure (minutes)	1½	1⅓	1	1	----	----	----	----	----	----	----	----	----	----	----	----
Time pressure maintained	3	2½	2	2	----	----	----	----	----	----	----	----	----	----	----	----
Per cent. of fat in milk used	4.40	5.00	4.80	4.60	4.40	5.00	4.80	4.60	4.40	5.00	4.80	4.60	5.60	5.10	4.80	4.80
Per cent. of fat in milk drawn from bottom in 2 hours,	2.475 2.20	2.514 2.20	1.80 1.60	2.25 2.00	2.20	1.40	1.60	1.60	0.60	1.00	0.60	0.60	----	----	----	----
Per cent. of fat in milk drawn from bottom in 4 hours,	1.46 1.30	1.60 1.40	1.125 1.00	1.575 1.40	1.60	1.20	1.00	1.20	0.40	0.60	0.40	0.50	----	----	----	----
Per cent. of fat in milk drawn from bottom in 10 hours, *a*	0.563 0.50	0.686 0.60	.514 0.40	0.643 0.50	0.40	0.40	0.30	0.20	0.20	0.30	0.10	0.20	----	----	----	----
Per cent. of fat left in milk after 22 to 24 hours,	1.063 0.90	1.44 1.20	1.688 1.50	0.80 0.80	0.40	0.525 0.50	0.40	0.40	0.40	1.44 1.20	----	0.20	0.20	0.10	0.05	0.05
Pounds of skim-milk after 22 to 24 hours, excluding samples drawn	15.25	14.28	18.50	----	10.7	----	10.63	----	----	----	----	12.7	35.25	29.5	34.75?*b*	33.0
Pounds of cream obtained	1.00	1.28	1.187	1.187	1.50	----	1.875	1.625	----	----	----	3.00	6.50	5.00	7.50	7.25
Pounds of cream per 100 of milk	6.25	8.00	7.42	7.42	12.00	----	12.50	9.28	----	----	----	18.75	15.48	14.44	16.67	17.28
Pounds separated or skimmed milk for 100 of milk used	----	----	----	----	----	----	----	----	----	----	----	----	83 93	85.20	77.22?	79.76

a. Percentages for 6 hours' setting, August 1st, were: Berrigan, 1.00 per cent.; corrected, 1.125; shallow pans, 0.60 per cent.; set in well water, 0.30 per cent.

b. Two pounds of separated milk not accounted for.

TABLE VII.—A Comparison of Butter made from Different Methods of Creaming and from Churning the Whole Milk According to Local Custom.

	From Berrigan Treated-milk.		From Shallow Pan Setting.	Deep Setting.		Centrifugal.	Whole Milk Churned According to Local Custom.	
	Cream Churn'd.	Skim-milk Churn'd.	Cream Churn'd.	Cream Churn'd.	Skim-milk Churn'd.	Cream.	Whole Milk.	Whole Milk.
Weight of cream or milk churned	6.40	50.625	6.875	12.625	31.00	25.25	30.	30.
Temperature of cream in F°	75	76	73	76	77	65	80	68
Temperature of room in F°	80	75	78	78	78	79	73	75
Temperature of outside air in F°	88	88	87	87	85	83	74	75
Temperature of granular butter in F°	77		75	77	81	68	78	69
Weight of fresh butter (pounds)	2.25	0.25	2 25	2.375	0.063	8.688	0.625	1.25
Weight of salt used (ounces)								
Weight of salted butter (*a*) pounds								
Time churned (minutes)	20.	20.	21	13.	20.	10.	26.	60.
Total milk used for each churning	62		59	58.5		163.	30.	30.
Pounds butter made for each 100 of milk	3.62	0 40	3.80	4.06	0.10	5.09	2.08	4.17
Pounds butter-milk drawn from churn	15.91	48.187*	19.06	19.94	32.00	20.31	25.625	38.00**
Per cent. of fat in butter-milk as drawn	4.00		3.20	3.20	0.20	2.00	2.20	
Butter-milk, less addition	5 71		9.06	9.94				
Corrected per cent. of fat in butter-milk	5.43		4.52	4.16				
Pounds of fat lost in butter-milk	.31		.4099	.414		.5125	.5638	
Per cent. of total fat lost in butter-milk	10.66		14.77	15.03		6.20	36.37	

* Re-churned and no appreciable amount of butter obtained, but 0.30 per cent. fat in re-churned butter-milk. ** Water added to gather butter.

a. Fresh butter worked enough to weigh, then all salted and worked together.

the percentage without the added portion. These are alarmingly high rates to be losing. If the assertion were made that these conditions largely prevail generally, and that these results occur more frequently in common practice than most people would wish to admit, the statement would not be incorrect.

There is a feature of the popular practice, however, which makes the apparent loss seem less than these percentages would indicate, as is shown elsewhere, in the common use of butter-milk, which has led to the saying that many people churn *for the sake of the butter-milk.*

If the weight of skim-milk from the Berrigan treatment on the 4th was equal to that of the 3d inst. in weight, then, by adding the fat in the butter-milk to that of the skim-milk, less what was drawn in sampling, the loss of fat would amount to 39.34 per cent. of what was in the milk. Combining this with the percentage found in the centrifugal skim or separated milk, with what was left in its butter-milk, it appears that 7.82 per cent. of the milk was thus lost. Nearly four-fifths of this was found in the two per cent. of fat of the butter-milk, while, on the other hand, except for a short time in summer, or under special conditions, the butter-milk from the centrifugal separated milk has contained only from 0.10 to 0.3 or 0.4 per cent. of fat.

Comparison of the Horizontal De Laval Separator with the Cooley Creamer under Winter Conditions.

When winter had set in with sufficient force to enable us to keep the temperature more nearly under control, this comparison was made. The two churnings first given below (Table VIII.), from the use of the centrifugal separator, show in detail the the work being regularly done with this machine in the Station dairy. The Babcock test has been used to determine the fat in all the products except the butter, which latter was analyzed by Mr. Kilgore, of the chemical division of the Station. In the first churning from the separator, 260¼ pounds of milk yielded 44¼ pounds of cream, from which 15 pounds of well-worked butter, salted one ounce to the pound, was made. A balanced statement of this churning shows the following:

Pounds of butter fat found in 260¼ pounds of milk		13.242
Pounds of butter fat recovered in 15 pounds of butter	12.844	
Pounds of butter fat recovered in 212.3 pounds of separated milk	.13243	
Pounds of butter fat recovered in 31.938 pounds of buttermilk	.0319	
Pounds of butter fat lost in the whole operation	.2337	
		13.242
Per cent. of butter fat recovered in butter		96.69
Per cent. of butter fat recovered in separated milk		1.00
Per cent. of butter fat recovered in butter milk		0.24
Per cent. of butter fat unaccounted for, except in loss at separator, on cream pails, in churn, and in wash-water for butter		2.07
		100.00

The second churning from 267⅛ pounds milk run into the separator, yielded 46¾ pounds of cream, from which 15⅞ pounds of butter

TABLE VIII.—Results of Two Churnings from Separated Cream by the Horizontal De Laval Machine under Winter Conditions.

Date.	Whole milk.	Per cent. fat.	Total fat.	Separated milk.	Per cent. fat.	Total fat in separated milk.	Cream yielded.	Cream churned.	Butter produced.	Butter milk.	Per cent. fat in butter-milk.	Total fat in butter-milk.
	lbs.		lbs.	lbs.		lbs.	lbs. oz.	lbs. oz.	lbs. oz.	lbs.		lbs.
Sunday, 25 .... A. M.	42.375	4.80	2.034	34.4375	00.05	.01722	7— 5					
P. M.	32.6875	5.80	1.919	26.8125	00.05	.01341	5— 7					
Monday, 26 .... A. M.	40.8175	4.80	1.959	33.00	00.05	.0165	6—15					
P. M	33.75	5.50	1.856	27.625	00.10	.0276	5—13					
Tuesday, 27 ...... A. M	39.75	4.80	1.908	32.8125	00.05	.0164	6—10	44—3	15—00	31.9375	.10	.0319
P. M.	30.50	5.60	1.708	25.	00 10	.0250	5— 2					
Wednesday, 28 .. A. M.	40.375	4.60	1.858	32.625	00.05	.0163	7— 0					
Total	260.2500		13.242	212.3125		.13243	44— 4					
P. M.	31.1875	5.60	1.747	25.5	00.070	.0191	5— 7					
Thursday, 29 .... A. M.	42.00	4.40	1.848	34 25	00.05	.0171	7— 6					
P. M.	32.750	5.75	1.883	26.8125	00.10	.0268	5—12					
Friday, 30 ...... A. M.	41.875	4.60	1.926	34.	00.075	.0255	7—12					
P. M.	31.375	6.00	1.883	26 00	00.10	.0260	5— 2	46—1	15—14	34.0625	40	.1363
Saturday, 31 ..... A. M.	50.9375	5.00	2.547	41 3750	00.10	.0414	9— 2					
P. M.	37.	5.80	2.146	30.0625	00.10	.0301	6— 3					
Total	267 125		13 980	218.		.1860	46—12					

salted, one ounce to the pound was made. A balanced statement of this churning shows the following:

Pounds of butter fat found in $267\frac{1}{8}$ pounds of milk		13.980
Pounds of butter fat found in 15.875 pounds of butter	13.2413	
Pounds of butter fat recovered in $34\frac{1}{16}$ pounds buttermilk	.1363	
Pounds of butter fat recovered in 218 pounds of separated milk	.1860	
Pounds of butter fat lost in the whole operation	.4164	
		13.980
Per cent. of butter fat recovered in butter		94.72
Per cent. of butter fat recovered in buttermilk		.97
Per cent. of butter fat recovered in separated milk		1.33
Per cent. of butter fat unaccounted for, except in loss at separator, on cream pails, in churn, and in wash-water for butter		2.98
		100.00

Average percentages recovered	in butter	95.705
	in separated milk	1.165
	in buttermilk	0.605
	in losses	2.525
		100.000

On the succeeding week, the first of January, 1893, the Cooley creamer received the milk. This was a cold period and temperatures could be kept under control without the use of ice. The milk cooled considerable between milking and setting. The result is shown in Table IX.

During the first part of the week $321\frac{1}{8}$ pounds of milk yielded $65\frac{15}{16}$ pounds of cream from which was made 14.875 pounds of well worked butter, salted one ounce to the pound. The balanced statement for this churning is as follows:

Pounds butter fat found in 321.125 pounds of milk		16.393
Pounds butter fat recovered in $14\frac{7}{8}$ pounds of butter	12.4534	
Pounds of butter fat recovered in 254.75 pounds of Cooley skim-milk	2.0439	
Pounds of butter fat recovered in 50.31 pounds of buttermilk	0.0503	
Pounds of butter fat lost in the whole operation	1.8454	
		16.393
Per cent. of fat recovered in butter		75.97
Per cent. of fat recovered in buttermilk		0.30
Per cent. of fat recovered in skim-milk		12.47
Per cent. of fat lost in handling for this churning		11.26

During the latter part of the week, there were 306.96 pounds of milk set, from which $73\frac{1}{4}$ pounds of cream was obtained. This yielded, on churning, $15\frac{7}{16}$ pounds of butter, well worked and salted, as above. A balanced statement of this trial shows the following percentages:

Pounds of butter fat found in 306.56 pounds of milk		15.434
Pounds of butter fat recovered in $15\frac{7}{16}$ pounds of butter	13.4044	
Pounds of butter fat recovered in $235\frac{7}{16}$ pounds of Cooley skim-milk	1.3675	
Pounds of butter fat recovered in $46\frac{3}{4}$ pounds of butter-milk	.0234?	
Pounds of butter fat unaccounted for, lost in the various operations	.6387	
		15.434
Per cent. of fat recovered in butter		86.85
Per cent. of fat recovered in skim-milk		8.86
Per cent. of fat recovered in butter-milk		0.15
Per cent. of fat lost in handling		4.14
		100.00

TABLE IX.—Results of two Churnings from Submerged Gravity Creaming with the Cooley Creamer under Winter Conditions.

DATE.	Whole Milk.	Per Cent. Fat.	Total Fat.	Temp of Milk when set. °F.	Temp. of water in Cooley Creamer. °F.	Skim-milk.	Per Cent of Fat in Skim-milk.	Total Fat in Skim-milk.	Cre'm yielded.	Cream in cl'dg skim milk used to rinse Cans, Churned.	Butter Produced	BUTTERMILK. Weight	BUTTERMILK. Per Cent. of Fat.	BUTTERMILK. Total Fat.
	lbs.		lbs.			lbs.		lbs.	lbs. oz	lbs. oz.	lbs.	lbs.		lbs.
Sunday, 1 ..... A. M.	55.875	5.00	2.794	81	50	45.0625	00.58	.2614	10— 7	69— 7	14.875	50.3125	.10	.0503
P. M.	37.0625	5.60	2.076	86	54	2.00 27.00	1.60 1.00	.3020	8— 2					
Monday, 2 ..... A. M.	50.125	4.80	2.406	82	54	40.5625	0.60	.2434	9—11					
P. M.	38.00	5.60	2.128	82	52	29.375	1.10	.3231	8—10					
Tuesday, 3 ..... A. M.	49.1875	4 80	2.361	80	51	39.00	0.75	.2925	10—00					
P. M.	38.00	5.50	2.090	84	50	29 8125	1 10	.3279	8— 5					
Wednesday, 4 . A. M.	52.875	4.80	2.538	80	50	41.9375	0.70	.2936	10—12					
Total............	321.125		16.393	82	52	254.75		2.0439	65—15					
P. M.	37.25	5 60	2.086	80	50	27.375	0.70	.1916	10— 1	74—13	15—7	46.75		
Thursday, 5 ... A. M.	54.875	4 80	2.634	80	50	27.6875	0.40	.1908	11— 3					
P. M	35.50	5.40	1.917	80	50	25.5	0.60	.1530	10—00					
Friday, 6 .... A. M.	57.00	4.40	2.508	74	50	45.6875	0.65	.2970	11— 5					
P. M.	33.00	5 00	1.650	76	48	24.6875	0.60	.1481	8—12					
Saturday, 7 ... A. M.	57.00	5.00	2.850	78	47	43.5	0.60	.2610	12—13					
P. M.	31.9375	5,60	1.789	78	49	21.	0.60	.1260	9— 2					
Total............	306.5625		15.434			235.4375		1.3675	78— 4					

An average of these results for the Cooley system churnings, the same as for the Centrifugal Separator churnings, shows the following average percentages to have been recovered: In butter, 81.41; in skim-milk, 10.665; in butter-milk, 0.225; in losses, 7.70.

Now, comparing the average results from both systems, there is seen to have been a loss from the Cooley system of 14.29 per cent. of the butter fat more than from the Centrifugal system. Part of this may have been due to lack of that expert deftness in handling the Cooley creamer which the more thorough acquaintance from every-day work had given with the Centrifugal machine. But it must also be remembered this test was chosen for the time of year most favorable to the gravity system in this climate; and when the comparison is made between the poorest result with the separator and the best with the gravity setting, there is yet about 8 per cent. of the butter fat saved in the butter by use of the separator. and 1.16 per cent. less loss from handling.

Calculating these four churnings on a cash basis of 25 cents per pound for butter, and separated milk, skim-milk and butter-milk at half a cent per pound (approximately 5 cents per gallon), the following advantage is shown from the use of the Centrifugal separator, compared with the next best system of handling milk on terms favorable to the latter:

TABLE X.—Showing Net Cash Results between the Cooley System and Centrifugal Separator System.

	Cooley System.		Centrifugal Separator.	
	Amount of product. lbs.	Value of product.	Amount of product. lbs.	Value of product.
First Trial:				
Total milk used	321.13		260.25	
Butter	14.87	$ 3.72	15.	$ 3.75
Butter-milk	50.30	.25	31.94	0.16
Skim-milk	254.75	1.28	212.31	1.06
Second Trial:				
Total milk used	306.56		267.13	
Butter	15.44	3.86	15.87	3.97
Butter-milk	46.75	.244	34.	.17
Skim milk	235.44	1.177	218.	1.09
		$ 10.52		$ 10.20

The centrifugal result is based on $527\frac{3}{8}$ pounds of milk; the other on $627\frac{11}{16}$ pounds. Total milk, 1155. pounds. If all had been handled by the Centrifugal separator at the same rate, the yield would have been $22.34. By the same proportion, if all had been handled on the submerged system, the yield would have been $19.36. The difference is $2.98 for the two weeks, using 82.5 pounds or $9\frac{1}{2}$ gallons of milk per day. This makes a cash difference of 21.3 cents per day on that amount of milk, or $2\frac{1}{4}$ cents per gallon of milk in favor of the Centrifugal system.

Any one can easily see from this result, as compared with the best of other modes of handling milk, the desirability of buying a separator. Thus, ten cows, giving two gallons of milk each daily for 300 days per year, would show a difference in favor of the Centrifugal separator of $135.00, or an average of ten cows at that rate for a full year of $164.25, which is more than sufficient to pay for the machine, with less work as additional profit.

Further Tests Made with Two Churnings of Separated Cream and One with Cooley Creamer.

In May, 1893, another comparison was made, but, owing to trouble with acid, some of the data for the second trial with the Cooley Creamer was lost, and the partial records are not here given. The following tables (XI. and XII.) give the results of these trials:

The Cooley Creamer was supplied with well water at about 60 degrees Fahrenheit. The Horizontal De Laval machine was run at 40 revolutions per minute by hand. This gave the 6,500 turns of the bowl required for it to do clean separating. At the end of the run, on the morning of the 15th, when the cream seemed to have stopped running, two ounces of milk were caught—the first which went to the skim-milk pail—and contained 2.10 per cent. of fat Sometimes there has been a leak where the milk enters the revolving bowl; at this time on the 16th at the morning run, there was a leak at that point, and six ounces of milk were caught which tested a little richer than the well mixed full milk. During the last period there were two runs, from which no fat in the separated milk could be detected by the Babcock Test. At other times the machine did the work about as it does regularly in our dairy.

The 615.28 pounds, separated for the two churnings, yielded 29.286 pounds of fat, of which 93.59 per cent. was found in the cream and from which 29.13 pounds of butter were made after samples had been removed for all the tests.

There were 382.906 pounds of milk creamed in the Cooley Creamer using well water without ice. In this milk 17.756 pounds of fat was found, of which 80.96 per cent. was found in the cream which made 15.00 pounds of butter salted the same as the other had been. This was at the rate of 3.917 pounds of butter for 100 pounds of milk, whereas the yield from the separated milk was 4.735 pounds per hundred of milk. The difference then is .818 pounds of butter which at twenty-five cents a pound, a fair price, amounts to 20.4 cents on each 100 pounds or 11½ gallons of milk. Results like these would add one and three-fourth cents (1.77 cents) to the value of every gallon of milk from the use of the separator.

TABLE XI.—Result of Churning with Centrifugal Systems, using the Horizontal DeLaval Separator.

MAY 1893.	Pounds Milk Separated.	Temperature of Milk. °F.	Per Cent. of Fat in Milk.	Pounds of Fat in Milk.	Cream. Pounds Separated.	Per Cent. of Fat in Cream.	Pounds of Fat in Cream.	Pounds of Separated Milk.	Per Ct. Fat in Separated Milk.	Pound Fat in Separated Milk.	PER CT. OF TOTAL FAT RECOVERED IN Cream.	PER CT. OF TOTAL FAT RECOVERED IN Separated Milk
First Churning.												
15 A. M.	64.375	90.	4.70	3.025	9.344	......	......	0.125 55.063	2.10 0.063	.0347	......	1.25
15 P. M.	74.313	93.	5.00	3.716	11.438	31.40	3.592	62.500	0.10	.0625	96.69	1.68
16 A. M.	55.312	92	5.00	2.715	8.125	32.00	2.600	0.375 46.56	5.10 0.05	.0424	93.69	1.53
16 P. M.	71.25	92	4 80	3.420	10.719	29.60	3,173	59.56	0.075	.0447	92.85	1.31
17 A. M.	54.25	88	4.90	2.658	8.156	29.40	2.398	45.38	0.075	.0340	90.20	1.28
Total	319.5			15.591	47.782		11.763	269.563				
Second Churning.												
18 A M	50.50	88	4 70	2.374	7.50	29.60	2.220	43.81	0.04	.0175	93 62	00.74
18 P. M	70 28	92	4.60	3.233	10.438	30.10	3 142	59.69	trace.	.....	97.16	
19 A. M	52.25	89	4 60	2.404	7.563	30.60	2.314	44.19	trace.	.....	96.26	
19 P. M	69.313	94	4.50	3.119	10.125	30.40	3 078	58.62	0.05	.0293	98.65	00.94
20 A. M	53.438	90	4.80	2.565	7.375	31.10	2.293	45.50	0.05	.0228	89.42	00.86
Total	295 78			13.695	43.001		13.047	251.81				

TABLE XII.—Milk Creamed by Cooley Creamer, using Well Water.

MAY, 1893.	Pounds of Milk Set.	Temp. of Milk Set. °F.	Temp. of Water. °F.	Per Ct of Fat in Milk.	Pounds Fat in Milk.	Pounds Cream obtained.	Per Ct. Fat in Cream.	Pounds Fat in Cream	Pounds Skim-milk.	Per Ct. of Fat in Skim milk.	Pounds Fat in Skim-milk.	Total per ct. of fat recovered in Cream.	Total per ct. of fat recovered in Skim-milk.
22 A. M.	53.875	90.	64	4.80	2.586	8.875	22.00	1 9525	44.25	0.80	0.3540	75.50	13.69
22 P. M.	73.75	94	68	4.80	3.540	13.25	20.40	2.703	60.438	00 70	.4239	76.35	11.97
23 A. M.	55 00	92	62	4 40	2 420	9 438	20.20	1.906	45.312	00.70	.3172	78.75	13.10
23 P. M.	75 00	96	68	4.40	3 300	12.75	22.00	2.805	62.313	00.70	.4362	85.00	13 22
24 A. M.	51.906	88	64	4.60	2.388	10.03	21.20	2 126	42.030	00.60	.2522	89.03	12.32
24 P. M.	73.375	94	68	4.80	3 522	14.00	20.60	2.884	59.625	00.80	.4770	81.88	13.54
Total	382 906				17.756	68.343		14.377	313.968		2.3025		

V. TRIAL OF THE U. S. HAND SEPARATOR, NO. 5.

This machine (Fig. 3.) was received from the Vermont Farm Machine Co., Bellows Falls, Vt., March 19, 1894. It was set up on the 24th and run after that date to the end of the month. The result below gives the data collected from using this machine.

Fig. 3.—U. S. Hand Separator, No. 5.

From some irregularity, the rubber ring in the neck bearing became softened and swollen at the end of the fourth run. The fifth run for this machine was made by the 10 gallon Victoria. After which, the ring having been replaced, this machine ran easily and continued to do so as long as used. As will be seen in the table below, the highest per cent. of fat found in the separated milk at any time was (00.05) five one hundredths of one per cent. This might have been reduced to "Trace" only, had we always run through separated milk enough at the end of each separation to thoroughly clear the cream from the bowl before stopping the machine.

We are satisfied that anyone, who will carefully read the instructions sent with this machine, can set it up and run it with little or no difficulty, and that it will thoroughly remove the fat, and some impurities from the milk which are left in the bowl.

The following Table No. XIII, shows the amount of milk run into the machine at each operation, the temperature of the milk, speed of driving crank, and time run. Fifty revolutions of the crank turn the bowl about 8,000 times. During the first runs it was more difficult to keep the speed uniform than after one is accustomed to it. The slowest and fastest turning by actual count for all the time the machine was run with milk in it, the starting and slowing being of course omitted, are shown in the table. The actual weights of cream and skim-milk obtained are given and these are calculated to percentages of pounds per 100 of the original milk. The per cent. of fat found by the Babcock test in both whole and separated milks is given, while from these has been calculated the per cent. of total fat recovered in the separated milk. The last column shows the number of pounds of butter made from one hundred pounds of milk, at each of the three churnings while this separator was used. The machine was run at a somewhat lower rate than instructions required, as the slower rate gave a thinner cream which was more desirable to

TABLE XIII.—Record made with the U. S. Hand Separator, No. 5.

DATE, MARCH, 1894.		Weight of Milk.	Temp of Milk at start. °F.	Turns of Crank per minute.	Time run in minutes	Weight of Cream obtained.	Pounds in 100 of Milk recovered as Cream.	Weight of Skim'ed Milk obtained.	Pounds in 100. Recovered as Separat'd Milk.	Per ct. of Fat in Whole Milk.	Per ct. of Fat in Separated Milk. (Babcock test.)	Per ct. of total Fat recovered in Separated Milk.	Pounds of butter made from 100 lbs. of Milk.
		lbs.				lbs.		lbs.					
Sunday, 25	A. M.	65.09	94.	52 to 55	19.½	11.156	17.18	53.56	82.29	4.65	0.038	00.67	5.94
	P. M.	46.00	86.	48 to 52	15.	8.28	18.00	37.78	82.13	5.80	0.05	00.70	
Monday, 26	A. M.	65.56	92.	44 to 54	19.	10.31	19.15	51.75	82.72	4.45	0.025	00.46	
	P. M.	48.72	85.	48 to 52	18?	8.75	17.95	39.66	81.40	6.40	0.025	00.32	
Tuesday, 27	A. M.	63 75	86.	48 to 50	35 ½*	10.09	15.83	50.88	79.81	4.85	trace.	....?	
	P. M.	49.67	84.	48 to 54	16	9.22	18.56	39.125	78.77	6.40	trace.	... ?	
Wednesday, 28	A. M.	57.50	84.	48 to 51	17	9.42	16.38	47.86	83.24	5.05	0.04	00 66	6.22
	P. M.	44.625	86.	48 to 52	14	7.50	17 03	36.78	82.44	5.80	0.03	00.425	
Thursday, 29	A. M.	59.31	86.	46 to 50	18 ½	9.91	16.71	48.97	82.26	5.00	trace.	. ?	
	P. M.	44.00	86.	48 to 52	14 ½	7.22	16.41	36.75	83.52	6.00	0.02	00.28	
Friday, 30	A. M.	61.81	84.	46 to 50	19 ½	9.97	16.13	51.34	83.06	4.95	0.05	00.83	5.87
	P. M.	42.03	86.	47 to 50	14 ½	7.59	18.06	34.00	80.89	6.00	trace.	... ?	
Saturday, 31	A. M.	62.43	84.	47 to 50	21	10.65	17.59	51.65	82.73	4.50	trace.	....?	
	P. M	49.87	92.	48 to 52	15	7 72	18 55	41.65	80.03	5.80	0.025	00.36	

*Run made by Victoria machine.

handle in the Davis Swing churn; which was used to churn the cream.

Table XIV shows similar data for the U. S. Separator, as was given for the 10-gallon Victoria Separator. In every churning, more actual butter is shown to have been obtained than there was fat in the milk. And when comparison is made between the actual and the possible amount of butter, at a standard of 85 per cent. fat, it is seen that the difference is very small. It is insignificant when it is remembered that losses occur in the separator feed can, on every vessel, and part, with which the milk comes in contact, a little is left in the cream can and some is lost mechanically in the churn and on the butter worker. There is one point, however, which has not been mentioned, *i. e.*, the composition of the butter actually made, may not be as dry as 85 per cent. fat. Had this point been determined and the possible amount calculated to be actual content of fat in butter, the loss may have been somewhat increased above that shown in the table.

TABLE XIV.—Results with U. S. Hand Separator, No. 5.

Date.	Pounds fat in Milk.	Pounds fat in Separated Milk.	Pounds fat in Buttermilk.	Pounds Butter possible with no losses and 85 per ct. fat.	Pounds Butter actually obtained.	Decrease of actual from possible yield if no losses occurred.
25 A. M.	3.027	.02035				
25 P. M.	2.668	.01889				
26 A. M.	2.783	.01290				
26 P. M.	3.118	.00990				
27 A. M.	3.091*	trace.	.02025			
	14.687	.06204		17.280	17.00	0.28
27 P. M.	3.1790	------				
28 A. M.	2.9040	.019200				
28 P. M.	2.5950	.011034				
29 A. M.	2.9655	------				
29 P. M.	2.6400	.007350	.02888		15.88	
	14.284*	.03758	.02888	16.80		.92
30 A. M.	3.0596	.025670				
30 P. M.	2.5200	------				
31 A. M.	2 8098	------				
31 P. M.	2.8830	.010406	.10575	13.261	12.69	.571
Total	11.272 40.245	.03608 .13570	.15488	47.341	45.57	1.771

VI. TRIAL OF THE 10-GALLON VICTORIA HAND SEPARATOR.

This machine is manufactured by Watson, Laidlaw & Co., Glasgow, Scotland. The circulars received with the machine state that there are sizes manufactured to separate 200, 400, 750 and 1,500 pounds of milk per hour. The Victoria Hand Separator (Fig. 4,) with which the following trials were made, was obtained from The Dairyman's Supply Company, Philadelphia, Pa., which company is the American agent for these separators. The machine is simple and has few parts, which are well illustrated and named in the "Instructions for Fixing and Working" the separator. No one who reads the instructions can fail to operate it successfully, or to intelligently order a new part for any worn one.

Fig. 4.—Victoria Hand Separator.

The first run made was with $50\frac{3}{8}$ pounds of milk, from which 16.315 per cent. of cream and 82.63 per cent. separated milk were obtained. Four samples of the separated milk were subjected to test in the Babcock machine, which gave so small an amount of fat that when duplicates were united there was considered to be but 00.025 per cent. of fat in the separated milk. The whole milk had tested 4.40 per cent. fat and the amount of fat left in the separated milk was found to be but 00.44 per cent. of the fat in the milk. The comparatively large loss of 1.05 per cent. of milk was due to the small amount operated on, as the few ounces required to wet cans and machine being larger in proportion than if more milk had been used. There was a lowering of about three degrees in the temperature of the milk during the separation which occupied $31\frac{1}{2}$ minutes.

Following this, other tests were made, mornings and evenings, with milk ranging from 89½ to 98° F, and running from 46 to 49 revolutions of the crank per minute up to 55 to 60 revolutions. The directions give 46 to 48 per minute as the right speed for the larger machine.

The higher speed of 58 revolutions, as printed on the arm of the crank, is considered the right speed for the 10 gallon machine to do clean work. We preferred the lower rate, as the cream was not so thick and churned better than did the thick cream secured when higher speed was attained. But by reference to table below, it will be observed that three times with the higher rate of speed we failed to find any fat in the separated milk, while at the lower rate the separation was only once found complete.

On the milk of two of the cows of the Station herd, particles of butter are found floating as soon as the cow is milked. Enough of these accumulated in the milk to stop the flow of cream from the machine at two separations on the mornings of the 8th and 11th. Other than these two, every run made was satisfactory. Below is a condensed table XV showing the data collected for each run, the percentages of cream and skim milk, of fat in milk before and after passing through the machine, and the pounds of fat left in the separated milk for every 100 pounds contained in the whole milk. In addition, the pounds of butter made from one hundred pounds milk has been added.

Table XVI has been calculated to show pounds of fat in the whole milk separated, in the separated milk, and in the buttermilk; also the pounds of butter which could have been made, if no fat in the milk had been lost, either in the separated or buttermilk, or used mechanically. Columns are given showing the butter actually made and the decrease from the possible amount. The column showing decrease was interfered with in two cases, by accident and by sale of cream. This table shows the close work which can be done with a separator and by churning properly ripened cream. In the handling of five churnings, including separating twice daily for twelve days, less than 10 ounces of fat was found by the Babcock test in the separated orskim-milk, and less than three ounces in the buttermilk.

TABLE XV.—Record made with the 10-Gallon Victoria Hand Separator.

DATE, M'ch, 1894.	Weight of Milk.	Temp. of Milk. °F.	Turns of Crank per minute.	Time Run in minutes	Weight of Cream obtained.	Pounds in 100. Recover'd as Cream.	Weight of Skimmed Milk. Recover'd	Pounds in 100. Recovered as Separated Milk.	Per Cent. of fat in Whole Milk.	Per Cent. of fat in Separated Milk.	Per Cent. of total fat recovered in Separated Milk.	Pounds Butter from 100 pounds of Milk.
	lbs.				lbs.		lbs.	lbs.	lbs.			
6 A. M.	50.375	92	47 to 50	31½	8.22	16 32	41.63	82.63	4.40	0 025	00.44	
P. M.	40.125	92	47 to 50	25	7.06	17.63	33.00	82.24	5.10	0.025	00.41	
7 A. M.	50.50	95	55 to 58	34¼	3 906	8.44	46.31	91.11	3.90	0.025	00 62	5.34
P. M.	37.09	98	55 to 57	22	5.25	14 16	31.44	84.75	5.40	0.025	00.39	
8 A. M.	61.81	89½	54 to 58	39	7.66	12.39	53.34	86.30	5.35	0.50	8.07	
8 P. M.	41.56	96	50 to 52	25	6.875	16.54	34.25	82.41	6.50	0.025	00.32	
9 A. M.	52.59	92	47 to 50	32	8.06	15.33	44.13	83.90	4.20	0.025	00.50	
P. M.	46.38	95	47 to 49	27	9.19	19.81	37.41	80.66	5.60	0.025	00.36	5.804
10 A. M.	55.66	92	46 to 50	34	8.38	15.05	46.97	84.45	4.30	0.025	00.49	
P. M.	45.00	92	47 to 49	28	7.19	15.97	37 31	82.92	5.20	trace.	....?	
11 A. M.	54.38	90	54 to 57	29?	7.19	12.76	47.13	86.66	4.60	0.30	5.65	
P. M.	51.00	92	54 to 60	30	7.41	14 52	43.19	84.68	5.30	trace.	.. ?	
12 A. M.	48.84	92	54 to 58	30	6.53	13.37	42.00	85.99	4.75	0.025	0.45	5.182
P. M.	41.00	94	55 to 58	24	6.03	14.71	34.94	85.21	5.55	trace.	....?	
13 A. M.	54.44	92	55 to 58	34	7.60	13.95	46.66	85.70	4.40	trace.	... ?	
13 P. M.	42.09	92	54 to 59	25½	6.56	15.59	35.38	84.04	5.40	0.025	00 39	
14 A. M.	53.97	95½	55 to 60	31	9.13	16.91	44 25	81.99	4.50	0.05	01.17	
P. M.	39.59	90	55 to 57	23¾	6.38	16.10	33.06	83.50	5.00	0.025	0.42	5.755
15 A. M.	57.47	95	54 to 59	33	10 38	18.05	46.97	81.73	4.60	trace.	....?	
P. M.	41.44	95	56 to 59	24	7.50	18.10	33.75	81.45	5.80	.075	1.05	
16 A. M.	58.34	93	48 to 50	34½	10.59	18.16	47.69	81.73	4.60	.025	00.44	
P. M.	38.28	93	48 to 51	23½	6.63	17.31	31.38	81.96	5.60	0.025	00.37	5.876
17 A. M.	46.56	94	47 to 50	28	8.88	19.06	37.38	80.27	4.60	0.025	00.44	
P. M.	44.03	92	46 to 49	25	9.06	20.58	34.38	79.25	5.75	0.025	00.34	

TABLE XVI.—Results with Victoria Hand Separator.

Date, March.	Pounds fat in Milk.	Pounds fat in Separated Milk.	Pounds fat in Butter-milk.	Pounds Butter possible to obtain at 85 per cent. fat and perfect separation with no losses.	Pounds Butter actually obtained.	Decrease of actual from possible yield.
6 A. M.	2.365	.0104				
6 P. M.	2.026	.00825				
7 A. M.	1.869	.0116				
7 P. M.	2.003	.0079				
8 A. M.	3.307	.2667				
	11.570	.30485	.0553	13.610	12.81	.80*
8 P. M. to 10 P. M.	12.244	.04065	.0078	14.405	14.00	.405
11th to 13th A. M.	12.195	.15187	.0602	14.347	12.94**	----
13th P. M. to 15th	11.728	.05348	.0141	13.798	13.50	.298
16th and 17th	9.499	.03783	.0430	11.176	11.00	.176
Total	57.236	.58868	.1804	67.336	64.25	

Comparing the results found in Tables XIII and XV, it is found that with the U. S. Separator in three trials, there was an average of 11.3 per cent. more butter made than there was fat in the milk handled. With the Victoria Separator, in the three trials in which no losses occurred, there was 13.5 per cent. more butter made than there was fat in the milk handled. These results show in another way how little fat could have been lost to obtain so much product.

No other known system can make such a showing as this. Nearly one-eighth more butter than butter fat in the milk after all the mechanical and other losses are taken out, and the butter going to market at the highest prices.

*Partly due to loss on 8th as noted above.

**This, corrected proportionally for cream sold, would be 14.17 pounds, and the decrease would be but .177 pounds from possible amount with no losses.

Miscellaneous

Agricultural Topics

ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

BULLETIN NO. 115

JUNE 22, 1895

372

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

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AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

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RALEIGH, N. C.

PREFACE.

The accompanying bulletin is another instalment of the press service matter supplied to newspapers throughout North Carolina, as well as to other agricultural journals. It is reprinted as a regular publication of the Station, because in many instances results of tests are given which are not recorded elsewhere. It affords also a convenient medium for distributing collectively the short reading articles prepared with much care for newspaper columns. The parts inserted herewith were issued during July, 1894, and March, 1895. In republishing these articles, the Station relies on the favor with which similar publications have been received in the past, as well as upon one of the mandates of the Hatch Act in endeavoring 'to aid in acquiring and diffusing useful and practical information on subjects connected with agriculture.'

H. B. BATTLE, *Director.*

THE EXPERIMENT STATION

AT RALEIGH, NORTH CAROLINA.

Why Pull Your Corn Fodder? Curing Cow Pea Vines—Value of Corn and Cob Meal—Cultivation of Onions—Read Questions and Replies.

September 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them, If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Title Page Changed.

The title page of the bulletins of the North Carolina Agricultural Experiment Station has been somewhat changed in appearance. Now the subject of the publication is given the prominent part so that the readers can easily see what the bulletins contain.

The Chestnut and its Weevil.

It is a well known fact that the weevil damages to a great extent the chestnut as a market crop. This is made the subject of bulletin 105 of the North Carolina Experiment Station. The life history of this annoying insect is described, and how the parent beetle lays her eggs in the immature husk or burr of the nut when still on the tree. The eggs hatch and if the nuts remain upon the ground the worms in about ten days bore their way out and enter the ground to pass finally into the adult state during the coming spring. It is altogether impossible to prevent the beetle from laying her eggs on the native chestnut trees in the forests, but in cultivated orchards of Spanish or Japanese chestnuts the treatment would be the same as for the plum curculio. For treating the nests, the following plan successfully followed by an experienced correspondent is recommended: scald the nests by placing a bushel or so in a tub, pour enough boiling water over them to cover one or two inches. Stir with a stick, allow to remain about five minutes, and the weevilly nuts come to the surface and can be skimmed off and destroyed or fed to hogs. Put the good nuts in bags half full, and dry in the sun, shake and manipulate freely to hasten drying. The kernels thus treated remain soft and do not get flinty.

The Army Worms.

The weather this year has been exceptionally favorable to the army worms of which we have two general namely, Laphygma frugiperda, the southern army worm, and Heliophila unipunctata, the northern army worm. This year the latter genus is the more common but both are troublesome. These worms prefer soft green millet, corn, small grain, grass, and clovers. The southern worm eats fruit and vegetables. They do not molest cotton, cow peas, peanuts, or tobacco; nor can they damage dry cured fodder, or ripened grain shocked or standing in field. They never damage fodder or grain in barn.

Remedies: When these worms attack a grass or forage field cut the crop at once and haul into barn or rake up into windrows as soon as cut. Have a man follow and spray or sprinkle with kerosene emulsion, or pure kerosene oil, or boiling hot water upon the worms which will be found covering the ground. The forage may then be cured as usual in field. To prevent advancing worms from getting into a field, plow a long, wide and deep furrow across their line of march, 5 or 6 feet outside the field to be protected. The land side must be towards the protected field, and should be cut under if practicable. When the advancing worms have half filled this furrow pile straw or dry pine tags upon them and fire; or plow another furrow just inside the last, throwing the dirt upon the worms. Roll or stamp this hard. Repeat furrows as often as necessary. When crossing roads or bare ground the worms may be crushed by driving a heavy roller over them, or kerosene may be sprayed upon them or dry straw or litter may be scattered and fired. They may be poisoned by Paris green, but this remedy is not desirable when the crop is to be utilized as forage. As soon as full grown the worms will enter the ground and change to the dormant pupa state in which they will remain until spring. Fields in which the worms have worked this fall should be deeply plowed and rolled heavily or stamped as soon as the worms are gone. This will bury the pupae so deeply they will not reach the surface in spring. Fall crops may be

sown as soon as the worms begin to disappear. Gerald McCarthy, Entomologist North Carolina Experiment Station.

Crimson Clover in 1894.

[A crop of seed $44.61 per acre.]

It is worth while to spread the fact to every farmer that this clover can and will bring dollars to him if he will but grow it.

This crop starts and grows to full maturity and dies between August and the following June. It will start among corn, cotton, or other crops and need not interfere with the crop for the latter part of the season in which it is sown. When the summer crop is gone, crimson clover takes the soil and provided it is not too poor, covers it with verdure and increases its fertility while preventing the unsightly washing which frequently occurs without its presence. It only holds the ground for a short time in spring against other crops. If grazed, no delay need be experienced in plowing for early crops but we would plow all other ground first, as the later this is left the more good it will do stock and land, and the better it will be for the following crop.

If it is made into hay the last of April will see it harvested and the weather will be propitious for hay-making. Indeed, it may well be questioned if it would not be better, for a cotton crop, to have the land in this clover for hay to cut at the time when cotton has usually hardly started in sickly yellow growth, and then turn the land at once and plant the cotton. The roots and stubble will have mellowed the soil and added a rich supply of plant food to push the cotton crop and save a heavy bill for fertilizers. If the crop is late it will doubtless make up the time in more rapid growth and if it is not quite so far advanced when bolls begin to rot some years in August, it may be as well for the crop. At any rate corn can be planted after crimson clover has been cut for hay or seed, and will find its best development after such a crop.

Now is the time to purchase seed and start to growing this valuable crop. Seed is cheaper than for years before. We would advise those who start to at least save their own seed.

To show some of the possibilities in this crop, a statement is appended of the crop grown on the experiment station farm in 1894. This is only what any farmer may equal or exceed, but it shows a profitable use of land for the winter months. Of four acres in clover 2½ were harvested in good order while 1½ acres were storm-beaten when ripe. The yield of seed in hulls on the unhurt portion was 1487 pounds per acre, valued at 3 cents per pound, a total of $44.61 per acre. On the storm-beaten portion the yield was 581 pounds per acre with a value of $17.43 per acre. This straw has been fed just as though it were prime hay, and teams have worked as usual on it with usual grain food. Corn crop on the land is now better because clover has been grown there. After the clover was cut off, the land plowed well, although elsewhere it was rather too dry to plow. The soil was darker colored than before and harrowed easily to a fine seed bed. We could but consider this soil permanently improved.

A great quantity of seed has been grown in Deleware this year and growers are advertising it for sale at very moderate rates. F. E. Emery, Agriculturist, North Carolina Experiment Station.

The Weather in North Carolina During 1893.

The North Carolina Experiment Station has just published the seventh annual report of its meteorological division constituting the North Carolina state weather service for 1893. This report gives, in details, the various meteorological conditions in various parts of North Carolina during 1893. The subjects treated embrace; list of the publications during the year; the annual meteorological summary for the state (and the sixty-six separate stations whose reports were used for compiling it) including observations of pressure, maximum and minimum temperature, precipitation, state of the weather, wind direction, crop conditions miscellaneous phenomena, etc.; normals for North Carolina; list of meteorological stations, observers, and crop reports; work embraced in the monthly meteorological bulletins and the weekly weather crop bulletin; also weather and temperature forecasts, cold wave and frost warnings, and list of stations receiving them. A valuable feature of the report is the table of comparisons between principal points in North Carolina and prominent places in the United States and abroad. These comparisons embrace normal precipitation and temperature for the whole year, for each of the four seasons, and each month of the year.

The pamphlet embraces sixty-three pages, contains a well prepared table of contents and index, and is replete with valuable information on weather conditions in North Carolina. It can be procured by application to Dr. H. B. Battle, Director, Raleigh, N. C.

Self-Sucking Cows.

Since the issue of our previous press bulletin on this subject, several communications have been received and two remedies proposed which our cor-

respondents are sure has proven efficient in curing the habit, in at least one case for the quassia method and several for the slitted tongue.

Boil a handful of quassia chips (can be found at any drug store) for several hours in about one gallon of water. Wash the cows teats in this after every milking for ten days. Always wash every time before milking, using a gallon of clean water in which a spoonful of pearline has been dissolved. If the milk tastes of quassia feed it to the pigs. The bitternes of the quassia remains in the cow's memory and prevents further trials at sucking after the ten days.

The other method consists in slitting the tongue near the point used to draw up round the teat in the act of sucking. Fasten the cow securely, and drawing out the tongue slit it a little to one side of the middle 1½ to 2 inches out towards the front and near the point. Then feed on soft bran mashes for a few days until the wound heals and it will be impossible for the cow to suck after that. One correspondent tried chair frames and side bars until tired out and desperate, when the mutilated tongue cured the habit.

Still we should spend little time on any cow we do not know to be a good one. The time can be better employed. F. E. Emery, Agriculturist, North Carolina Experiment Station.

Advanced Summary of Meteorological Reports, for North Carolina, August 1894.

The North Carolina state weather service issues the following advanced summary of the weather for August, 1894, as compared with the corresponding month of previous years:

TEMPERATURE—The mean for the month was 74.7 degrees, which is 1.1 degrees below the normal. The highest monthly mean was 78.6 degrees at Lumberton: the lowest monthly mean was 65.8 degrees at Highlands. The highest temperature was 99 on the 9th at Saxon, on the 10th at Rockingham; the lowest 48 on the 5th at Blowing Rock, on the 6th at Bakersville. The warmest August during the past twenty-one years was in 1888, mean 78.5; the coldest in 1874, mean 73.3.

PRECIPITATION — Average for the month 6.13 inches, which is 0.04 inches above the normal. The greatest amount was 14.99 at Pantego; the least amount, 0.83 at Mt. Airy. The wettest August occurred in 1887, average 9.39. The duest in 1881 average 2.91.

WIND—Prevailing direction, northeast. The normal direction for August is southwest. Average hourly velocity 6.1 miles. Highest velocity, 38 miles per hour from northwest on the 13th at Chattanooga, Tenn.

MISCELLANEOUS PHENOMENA — Fogs were frequent especially during the latter part of the month, and considerable hazy occurred in upper sky. Thunder storms occurred on every day except 7th, 22d, 23d, and 24th. Hail occurred 10th, 15th and 19th. Luner Halos 21st; solar halos 11th and 25th. Two observers reported aurora early morning of 20th.

Questions and Replies.

The station will be glad to extend its usefulness by answering, as far as possible, questions on agricultural topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the "North Carolina Agricultural Experiment Station, Raleigh, N. C. Replies will be written as early as possible by the member of the station staff most competent to do so, and when of general interest, they will also appear in these columns.

Scuppernongs Can Be Pruned.

"I am emboldened by your former kindness in asking for some information concerning grapes. There is an abandoned vineyard near here comprising several hundred scuppernong and two varieties of bunch grapes names unknown. These vines have in most instances fallen from the decayed trellises and lie in heaps on the ground, a prey to goats and cattle. Such fruit as matures is, of course, absorbed by negroes in the neighborhood. Now I wish to ask if, in your judgment, these old vines after ten years of neglect, could by pruning and manuring be given a renewed life? And could I cross or graft to advantage? G. W. S. Wilmington, N. C."

[Answered by W. F. Massey, Horticulturist, North Carolina Experiment Station.]

The notion still prevalent that the scuppernong grape and all the rotundifolia class will not endure any pruning, is an error. You can prune and get the old scuppernong up on a horizontal trellis without much risk, but it will be found that the branches have rooted fast to the ground in all directions, and it will probably pay better to select strong young shoots with masses of roots and detach them as independent vines for planting, rather than bother with the old stems. In such a mass of vines as you describe you can get hundreds of strong young plants.

Bones as Fertilizers and How to Utilize Them.

"I am trying to make a study of fertilizers, having lately engaged in fruit growing in vicinity of Southern Pines. I have much of it yet to learn. I would be glad to have you send me any bulletins you may have on fertilizers. I am much pleased with the one you sent me on fruits. I would thank you to give me information on the following points:

1. What is the actual value of bone meal as a fertilizer for fruits, especially grapes. 2. Do you think it would pay to buy bones at $10.00 per ton and grind them in a hand bone mill? 3. Do you think it would impair the virtue of the bone to char it before grinding? 4. How would

old bleached bones compare with fresh ones in value? 5. Would it pay to simply break bones and plant pieces near each vine? 6. About what would be the value of tankage as a fertilizer per ton? 7. Any information you may give me in this connection will be very gratefully received. Is there any way of treating bones with acids that would be better and cheaper than grinding them? G. A. W., Wilmington, N. C.

[Answered by H. B. Battle, Director, North Carolina Experiment Station.]

Bone meal is a very valuable fertilizer for grapes, as well as other fruits. Grapes especially require it and can be greatly improved by its application. The phosphoric acid present is the material most utilized by the roots; there is some nitrogenous material present also, especially in fresh bones. It would pay to buy bones at $10.00 per ton and grind them in a hand mill if the mill is effective and grinding will not cost you too much. The charring of the bone liberates the nitrogenous material and hence some of the value is lost. The same action results when bones are left to bleach in the sun. It would pay to break the bones as fine as can be conveniently done to be planted near the vines. It is not an uncommon thing to find roots of the grape vine entwining themselves completely around a piece of bone in the soil. The fertilizing ingredients of tankage are 9 per cent. of ammonia, and 11 per cent. of phosphoric acid, of which about 5 per cent. is available; comparing values as given ordinary fertilizers, this would equal about $32.00 per ton. Treating bones on the farm with acids to dissolve them is not advisable because of the danger attending the operation. A plan found successful is the following: Dig a deep trench in soil not liable to leach, then lay down a layer of broken bones an inch or two, upon this lay similar layer of unleached hard wood ashes, repeating the process and wetting the layers until the trench is filled. It would be well also to have stakes at certain points in the mixture so that they can be withdrawn from time to time and water poured in the holes. This will tend to decompose the bones, but five or six months will be needed. As the decomposition will depend upon the quality of the bones, after this time if the bones are found not to be thoroughly decomposed you can fork over the material, lay down again with more ashes and wet the mixture and allow a longer time.

Hollow Horn and Hollow Tail.

Please state what causes the disease of cattle known as "hollow horn" and what is the remedy? Also how to prevent the disease. H. C. C. Colletsville, N. C.

[Answered by Dr. F. P. Williamson, Consulting Veterinarian, North Carolina Experiment Station.]

According to the popular idea, cows have only two affections "hollow horn," and "hollow tail."

The method of diagnosis between the two is simply by exclusion. If the cow is unthrifty and the cause is not from "hollow tail," she is suffering from "hollow horn." If she is unthrifty and the cause is not from "hollow horn," she is suffering from "hollow tail." It furthermore seems as if the disease was at the option of the diagnostician (?) either "hollow horn" or "hollow tail."

The popular treatment of these popular diseases is simple, but radical. If your cow is suffering with "hollow horn," cut off the horns, she will never have "hollow horn" again. If she, at the mercy of her would-be helpers, is said to have "hollow tail," then it is that one more cow is doomed to be a "bob-tail" without the means to defend herself against the flies and insects that pester in the spring and fall. "Hollow horn," off with the horns! "Hollow tail," off with the tail! The diagnosis is simple; the treatment secures sure cure with no chance of recurrence.

We cite two cases in illustration to show the incorrectness of these common notions.

Case 1, October 9th, 1893. Patient—cow, age unknown. Appearance unthrifty, dry staring coat, pulse small, quick, breathing accelerated, temperature elevated. Had been running in oak grove several days eating large quantities of acorns. Man in charge was unable to decide whether she was suffering from "hollow horn" or "hollow tail." It was plainly a case of plenalvia, and a purgative dose was administered, followed by digestive tonics. The patient made quick recovery.

Case 2, April, 1894. Patient—Nice Jersey cow, age not known.

Had been treated for "hollow tail" some time before by a friend (?) of the owner. General unthrifty appearance, febrile symptoms. Put on tonics, (nux vomica and iron) is doing well.

That it is possible for the tail of a cow to suffer from many diseases that flesh and bone "is heir to" (caries of the bone, inflammation of the soft tissues, skin diseases of many kinds, diseases of the hair and follicles) we readily admit; but to take away from a poor dumb brute the only defence she has against a troublesome insect world for a fancied cause that has no existence in reality, is certainly unjust, if not barbarous.

As for the horns, it is probably a good thing to take them off, if properly done. Many dairy men have their entire herd dehorned, as they claim cows in state of domestication have no need for this mode of defense, that horns only cause trouble by wounding udders and other soft tissues.

THE EXPERIMENT STATION.

AT RALEIGH, NORTH CAROLINA.

Valuable Publications For Free Distribution—Keeping Sweet Potatoes and Tomatoes in Winter—Russian Thistle—Destroying Weevils.

Read Questions and Replies.

October 1894.

Recent Bulletins of the Experiment Station

Bulletins will be sent to addresses in North Carolina free of charge. To parties outside of the state a small fee of 6 cents each (10 cents each for Nos. 73 and 92) is charged, or 25 cents per year. Only a limited number can be sent to each address, and the Station therefore must request parties to confine their applications to actual needs. Apply to Dr. H. B. Battle, Director, Raleigh, N. C.

No. 78. Some Injurious Insects, plates 37, pp. 32.
No. 79. Facts for Farmers in Plain Language for Farmers' Reading, pp. 24.
No. 80. Silos and Ensilage, pp. 17.
No. 81. Feeding Cotton-seed Hulls and Meal for the Production of Beef, pp. 28.
No. 82. Fertilizer Analyses and the Fertilizer Control for 1891, pp. 20.
No. 83. Growing Celery in the South; Cultivation of Onions; Notes of Horticultural Work During 1891, Figs. 2, pp. 20.
No. 84. Some Enemies of Truck and Garden Crops, Figs. 32, pp. 26.
No. 85. The Late Crop of Irish Potatoes in the South, pp. 10.
No. 86. Tobacco Curing by the Leaf; Cure on Wire and the Stalk Processes, pp. 32.
No. 87. All Publications of the Station, from March, 1877, to September, 1892, pp. 20.
No. 88. Fertilizer Analyses, and The Fertilizer Control During 1892, pp. 24.
No. 89. Co-operative Field Tests During 1891 and 1892, pp. 48.
No. 90. Practical Stock Feeding, pp. 32.
No. 91. Some Experiments in Wheat Culture, pp. 20.
No. 92. The Culture of Orchard and Garden Fruit, Figs. 91, pp. 148.
No. 93. Feeding Experiments, pp. 48.
No. 94. Horticultural Tests and Results with Vegetables, Fruits and Bulb Culture, pp. 20.
No. 95. The Fertilizer Control During 1893. pp. 32.
No. 96. Miscellaneous Agricultural Topics, Figs. 19, pp. 32.
No. 97. Digestion Experiments, Fig. 1, pp. 48.
No. 98. Some Leguminous Crops and their Economic Value, Figs, 9, pp. 40.
No. 99. Thread Worm of Pork (Trichina Spiralis), Figs. 9, pp. 8.
No. 100. Our Common Insects, Figs. 65, pp. 36.
No. 101. The Progress of the Dairy Industry in North Carolina, pp. 8.
No. 102. Encouragement to the Dairy Industry of North Carolina, pp. 12.
No. 103. Miscellaneous Agricultural Topics. pp. 24.
No. 104. Why Pull Your Corn Fodder, pp. 4.
No. 105. The Chestnut and its Weevil, Nut Culture, pp .12.
No. 106. Practical Stock Feeding and Rations, pp. 44.

Keeping Sweet Potatoes Through the Winter.

The following method I have found to keep sweet potatoes in perfect order until June. Procure a good supply of pine straw from the woods in a dry time and keep it under cover ready for use. Dig the potatoes as soon as frost cuts the vines, If not convenient to dig at once, cut the frosted vines off at once, or they will harbor fungus growth that will damage the potatoes. Dig on a warm sunny day—lay the potatoes along the row as dug, and do not allow them to be bruised by throwing into piles. Handle at all times as gently as eggs. Allow them to lie in the sun during the day, and in the evening haul to a convenient place. Place a good layer, a foot thick, of pine or other straw on the ground, and on this, pile the potatoes in steep heaps, not over 25 bushels in a pile. Cover the piles thickly all over with the dry pine straw—now build a rough board shed over the piles, and let them remain until the weather grows colder, or until they have gone through a sweat and dried off. Then cover the heaps with earth six or eight inches thick and beat smooth. The important points are the sweating under the previous cover ofthe pine straw be-

fore covering with earth, very careful handling, and the board cover overhead. Dry earth keeps out more cold than wet earth. If for family use, put in smaller piles and take up an entire heap at once for use, keeping them in a dry warm place while using.—W. F. Massey, Horticulturist, N. C. Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, September, 1894.

The North Carolina State Weather Service issues the following advanced summary of the weather for September, 1894, as compared with the corresponding month of the previous years:

TEMPERATURE.—The mean for the month was 72.2 degrees, which is 2.0 degrees above the normal. The highest monthly mean was, 76.2 at Hatteras; lowest monthly mean, 63.2 at Highlands. The highest temperature recorded was 100 on the 9th, at Auburn; lowest, 39 on the 21st at Bakersville. The warmest September during past 21 years was in 1881, mean 74.9 degrees; the coldest, in 1875, mean 67.0.

PRECIPITATION. — Average for the month, 4.77 inches, which is 0.12 above the normal. The greatest amount was 7.93 inches, at Chapel Hill; least amount, 1.07 at Mt. Airy. The wettest September occurred in 1877, average for the state being 10.13 inches; the driest was in 1884, average, 2.04.

WIND.—Prevailing direction, northeast, which is the normal direction for this month. Average hourly velocity, 7.5 miles. Highest velocity, 60 miles per hour from the northeast, at Kitty Hawk, on the 27th.

MISCELLANEOUS.—Thunderstorms occurred at one or more places on the 1st, 2d, 3d, 4th, 5th, 8th, 9th, 10th, 11th, 12th, 17th, 18th, 24th.

Hail occurred on the 1st, at Lilesville, Bailey, and Auburn.

Light frost reported at Blowing Rock on the 21st, and at Flat Rock on the 22d.

On the 27th a general storm prevailed, doing more or less damage to crops, especially cotton which was open in the field.

The Russian Thistle.

One of the most noxious of recent emigrants from Europe is the socalled Russian thistle, Solsola Kali, var. tragus.* This weed is a native of Russia where it has long been known as a terrible pest in the wheat fields of that empire. In this country it first became troublesome in the wheat-growing section of the Dakotas. It has since spread into many of the western and northwestern states. Such is the magnitude of this pest that the Senate of the United States in the last session of congress, passed a bill appropriating $1,000,000 for exterminating it, but the appropriation failed to become a law.

It is the nature of this weed when ripe to lose its hold upon the soil and roll up into a ball. In this form on the level windy prairies of the northwest it is blown for hundreds of miles, spreading its seeds far and wide. While growing each plant forms a thick close patch killing out the grain, and may in this way ruin an entire field. The seeds of this weed are liable to be brought to North Carolina and other Southern states with baled hay from the western states. While in our more hilly country the pest is not likely to become so injurious as it has now become in the west, it may still be able to cause the farmers of this state great loss.

RUSSIAN THISTLE.—(Mature form of one branch) b. represents a seed. The cut to the left shows a young branch.

The cut shows the general appearance of the mature thistle and seed, also a branch of a young plant. It is hoped that our farmers will keep a

sharp look out for this weed, and exterminate it as soon as it appears. It is a dry land plant and will be most troublesome on uplands.

The grave responsibility for introducing this and other noxious weeds such as the Canada thistle, must be accepted by those improvident farmers who buy and use western hay while living in a country able to produce as good hay and forage as any land upon which the sun shines.—Gerald McCarthy, Botanist, N. C. Experiment Station.

Error in Report of Crimson Clover Seed Yield for 1894.

A recent press article gave the crop of seed for this year grown at the Experiment farm at $44.61, per acre. When this statement was made a portion of the field recently added, was unintentionally omitted from the calculation of the yield. We hasten to make the correction. This increased area would reduce the value of seed to $31.86 per acre. However if the straw were included, the total value would be about as first reported.

The crop of unhulled seed in 1893 was 1,956 pounds per acre, which at the low price realized this year, would amount to $58.68 per acre, or $18.07 per acre more than the crop for 1894 as first reported.

The loss by weather-beating amounted to $14.43, which is enough to emphasize the necessity of employing every means possible to save the crop in good weather. On this point the Experiment Station expects to have a seasonable article for next spring before the seed is ripe.—F. E. Emery, Agriculturist, N. C. Experiment Station.

Pea and Bean Weevils.

Many hundred bushels of garden peas and beans, cow peas and soja beans will be destroyed by weevils in this state during the coming winter, unless proper treatment be used. These weevils are two species of the genus Bruchus B. pisi, the pea weevil, is the larger and is blackish with white spots. It attacks only garden peas, never garden beans or the cow pea, which is a true bean. The bean weevil, B. fabæ, is a rather small yellowish hairy insect. This weevil never attacks garden peas, but is the greatest pest of beans and cow peas. Both species lay their eggs, upon the growing pods in the field and garden. The eggs hatch in a few days and the young grub bores its way into the seeds. The grub lives within the seed until it has completed its growth and become a perfect or winged insect. The pea weevil never lays her eggs upon hard or mature seeds; the bean weevil in a warm climate like ours, grows from the egg to the winged state in about two months. The female at once lays her eggs upon the hard and mature beans or cow peas, and these in turn mature and produce other insects and the process may continue, as many farmers know to their cost, until the whole package of beans or cow peas is consumed.

REMEDY.—The cheapest and most effective remedy for both weevils is Bisulphide of carbon. It is a good plan to run the seed through a fanning mill shortly after gathering. This cleans the seed and destroys many eggs on the bean. Garden peas and beans kept for seed and cow peas should always be treated with this substance before being stored away and as soon as possible after being harvested. Place the loose seeds in a tight barrel which should not be quite full. On top of the seeds place a saucer containing three or four tablespoonsful of the bisulphide. Cover the barrel tightly with a cover upon which should be placed a heavy cloth of any kind except rubber or oil cloth. The bisulphide will quickly vaporize and penetrate the entire mass of seeds killing every grub and beetle. Allow the covered barrel to stand for twenty-four hours, then remove the cover and permit the fumes to escape. Never bring a light into or near the room while the fumes can be smelled as bisulphide of carbon is very inflammable. The smell of this liquid is objectionable, but it is not lasting. The bisulphide may not kill the eggs and to insure complete satisfaction repeat the bisulphide treatment after thirty days. Bisulphide of Carbon may be ordered in quart or pint cans from any dealer in chemicals, for about twenty cents per pound. Most druggists can supply it in smaller quantities but at a higher price.—Gerald McCarthy, Entomologist, N. C. Experiment Station.

Ripening Tomatoes in Winter.

Among the many plans that have been proposed for saving the tomatoes which remain unripe at the coming of frost, we have found the following the most satisfactory:

When sharp frost is imminent gather all the green tomatoes. Wrap each separately in paper—old newspapers will do. Now pack them in boxes and store in a cool place, just warm enough to be secure from frost but not warm, the object being to keep, not to ripen them. Bring out a few at a time as they are wanted, and place in a warm place to ripen a few days in advance. In this way we have for several years had sliced tomatoes on our table up to the middle of January.—W. F. Massey, Horticulturist, N. C. Experiment Station.

Questions and Replies.

The Station will be glad to extend its usefulness by answering as far as possible questions on agricultural topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C., Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station desires in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Variety of Asparagus for Planting.

"What kind of asparagus seed would you advise me to plant? Where can I get them? If I plant seed now can I expect any crop next spring?"—J. E. B. Manly, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

There is little difference in varieties of asparagus. Rich soil and good culture will make good shoots from any kind. The Palmetto is now the most popular sort. You can get the seed from any good seedsman. Seed sown in the spring and well cared for in good soil will make you good roots for setting the next fall, and the second year after setting you may get a fine crop. You will get no crop next spring from seed sown now.

To Destroy Sprouts and Stumps.

"What is the best way and when is the best time to destroy sprouts from an aspen tree which come up in my yard?"—H. B. B. Raleigh, N. C.

(Answered by Gerald McCarthy, Botanist.)

The aspen is botanically a poplar—Populus tremuloides and is one of the most inveterate sprouters. The best time to destroy the tree and so prevent future sprouts is about August 15, at which time the roots are nearly exhausted by the summer growth and have not yet began to store reserve material for next years growth. To get rid of the tree now the best plan is to cut it down and dig out the main roots. Next year keep the sprouts closely cut off and they will soon die out. Patent root destroying chemicals are of very little value and cannot be depended upon.

Creamer, or Separator for Southern North Carolina.

"I want to buy a creamer. Will you please recommend the best make. The Cooley submerges the milk and requires ice. Without ice is the Cooley as good as any other make?"—R. B. C., Charlotte, N. C.

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

The Cooley is as good as any gravity creamer we know, with or without ice. We would recommend you to think of a separator if you have as many as five or six cows, or if not so many to increase the number and use one or both to reduce labor while saving its cost in butter over common methods of creaming. The gravity methods lose enough which the centrifugal saves to pay for the latter in a reasonable time.

The machines we have tried and can cheerfully recommend are, the Victoria and United States separators. The latter is made by the makers of the Cooley creamer. (The Vermont Farm Machine company, Bellows Falls, Vt.,) who will be reluctant to sell you a creamer to use in our climate without ice, but who know their separator will give you satisfaction here. The Victoria is sold by the Dairymen's Supply company, Philadelphia, Pa., and is a nice perfect acting machine.

Bees and Bee Worms.

"What will kill bee worms and what is the best time to move bees?"—M S. C., Walnut Cove, N. C.

(Answered by Gerald McCarthy, Entomologist, N. E. Experiment Station.)

The "bee worm" is the larvæ form of a medium sized dark grey moth, Galleria melonella, a native of the old world but now everywhere introduced in this country. The most satisfactory remedy is to keep only strong colonies of Italian bees. These are so active that they will not permit the worms to remain in their hives if they can get at them. Only movable frame hives should be used. Another plan is to remove the frame, brush off all webs and kill the worms therein, then with a sharp pointed knife cut out the worms tunneling the comb. Where there are many frames infested they may be piled loosely or hung in a tight box or barrel and two or three tablespoonsful of carbon bisulphide in a saucer placed on top of the pile and the box or barrel covered tightly for twenty-four hours. Then remove the covering and expose the frames to the air till all odor of the carbon bisulphide has evaporated. Do not bring this substance near a fire or light as it explodes very easily. Pieces of comb, dirty frames. etc., should never be permitted to litter hive yards or honey houses as the worms breed in such.

As to moving bees if you mean to remove them to a house for the winter it should not be done until severe cold weather sets in or better still not at all. Use chaff hives or cover the hives with burlap sacks or padded sheets in cold weather. In this climate bees do not long remain dormant in winter. If you mean to remove bees from one location to another the best time is in early spring—two or three weeks before the bees begin to fly. The entrance to hives should be contracted until the bees have become accustomed to their new location.

THE EXPERIMENT STATION.

AT RALEIGH, NORTH CAROLINA.

Peach Orchard—Value of Manure—Weather During October—Improve Your Stock and Feed Rationally—Read Questions and Replies.

November 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. They are specially prepared to be serviceable as far as possible to the practical farmer. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them as we have none to throw away. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Setting Out a Peach Orchard.

Use trees only one year from the bud, and don't buy them from a tree agent, but get them from a nurseryman who will not cheat you. In planting don't set them any deeper than they grew in the nursery. Trim the bruised ends of broken roots smooth with a sharp knife. Then trim off clean all the branches made in the nursery and cut the stem square off at the height you want to form the head, leaving the tree about the size of an ordinary walking-stick. When growth begins in spring the buds will start all along this stem. Rub off all except three or four at the top which will make the future head. The next winter these shoots should be shortened one-half and the same practice followed annually. Plant 16x16 feet and cultivate in a hoed crop. In fall sow crimson clover and plow it under in spring for manure.—W. F. Massey, N. C. Experiment Station.

Value of One Day's Cow Rations as a Fertilizer.

The ration, costing about 22 cents per day, fed a certain cow at the State Fair of 1894, consisted of the following amounts:

	Nitrogen.	Phos. Acid.	Potash.
32 lbs sweetpotato vines	.1239	——	——
20 lbs corn fodder (field cured)	.1539	.0427	.057
4 lbs cotton seed meal	.2528	.1100	.070
8 lbs wheat bran	.1892	.2068	.068
Total	.7188	.3695	.195
Used by the cow (estimated at 20 per cent)	.1438	.0719	.039
Excreted for plant food	.575	.2876	.156

Taking the trade values of these adopted by this station for 1894: 5 cents per pound for potash and phosphoric acid and nitrogen, 18.2 cents, gives the following value for the plant food residue of the above ration:

.575 pounds nitrogen @ 18.2 cents	10.465 cents
.288 pounds phos. acid @ 5 cents	1.440 cents
.156 pounds potash @ 5 cents	.780 cents
Total valuation	12.685 cents

Here is a saving of 12¼ cents per day from the original ration, costing 22 cents, to be used in increasing the farm crops, provided none of it is lost.

Losses of nitrogen occur very easily. Just at the point, where the excrement is voided, 25 to 60 per cent of it is returned to the atmosphere unless especial care is taken to fix it by use of dry fresh soil or large amounts of gypsum. No homoepathic doses can prevent the losses. Dry soil is best when freely used, because cheapest and more likely to be used in quantity to accomplish the object.

Suppose the loss to be 50 per cent. of nitrogen 5 cents per milch cow per day. This saved or even half-saved will pay high wages to the man in charge of a herd who saves it by keeping a quantity of fresh soil or gypsum on hand for it. Gypsum has an effect of its own on soil and crops by adding lime where deficient, which can be a help toward returning its cost where used.

This station has long used acid phosphate and kainit in equal parts by weight behind the cows to help save the nitrogen. Half a pound to three-fourths of a pound, per day and cow is sprinkled down after the stable is cleaned, so as to begin action on any liquid that comes in contact with it.—F. E. Emery, Agriculturist, N. C. Experiment Station.

North Carolina Weather During Oct. '94.

The North Carolina State Weather Service issues the following advanced summary of the weather for October 1894. as compared with the corresponding month of previous years:

TEMPERATURE.—The mean temperature for the month was 59.8 degrees, which is 0.1 deg. above the normal. The highest monthly mean was 65.9 degrees at Newbern; the lowest monthly mean was 51.2 at Highlands. The

highest temperature was 90 degrees on the 1st at Southern Pines, the lowest was 24 on the 15th at Bakersville and Highlands. The warmest October during the past twenty years occurred in 1881, mean 66.4 degs.; the coldest in 1873, mean 55.8.

PRECIPITATION. — Average for the month 5.50 inches which is 1.84 inches above the normal. The greatest amount was 9.28 inches at Fair Bluff; least 1.98 at Bakersville. The wettest October occurred in 1887, average precipitation 6.72: the driest in 1892 average 0.92.

WIND.—Prevailing direction northeast, which is the normal direction. Average hourly velocity 8.2 miles. Highest velocity 60 miles per hour from the southwest on the 10th at Hatteras.

MISCELLANEOUS.—Number of clear days, 19, partly cloudy 5, cloudy 7, number of rainy days 7. Dates of thunderstorms 3d, 9th, 13, 25th, 26th, 27th, 28th, 30th; hail 9th 27th; the first light frost of the season occurred at Waynesville on the 5th; killing frosts occurred from the 14th to 16th at most stations except near the coast.

The cyclone of Oct. 8th to 9th caused heavy rains, and flooding of low lands in central and eastern part of state.

Flowering Bulbs in North Carolina.

The Experiment Station is investigating the question whether flowering bulbs for commercial purposes can be successfully grown in this state. A bulletin (107) has just been issued describing the propagation of a good many varieties of bulbs, as well as the adaptability of their growth to the soils of the central and eastern sections. The bulletin is illustrated with 23 life size cuts of bulbs grown at the Station. The growing of the bulbs require skill and experience, and it is not advisable for any one not possessing these to attempt it. If the Station demonstrates that some of our soils are suitable a large industry may be built up in our midst, and thousands of dollars annually will be brought to the state that otherwise would go abroad to Europe for import orders.

Improve Your Stock.

It has been well said that the male is half the herd. And yet how few of us practice on the side of improvement by making this smallest and least expensive half the best that will increase the value of our growing stock The head of a small flock of sheep, when of a standard excellence, costs but a trifle more than a mere scrub, when the difference in the value of the progeny is considered. The difference arises from the prepotency of the thoroughbred male derived from generations of well-fed and well-bred ancestors. The same is true of neat stock, of horses, of swine. It is often the case that the first cross from a thoroughbred sire produces an animal which for appearance and production of meat or milk is as profitable as though thoroughbred itself. The second and third cross from the pure bred sire, or, better, another of the same breed, becomes for all practical purposes as good as the pure breed except for breeding.

In a line of such breeding as this fatten the males for market as early as possible; whether as lambs or yearling mutton, or veal and beef. Those who have not tried a thoroughbred sire on common stock will be well pleased with the result, especially if they practice a rational system of feeding their stock. Well-bred stock can be easily reduced in production by careless or poor feeding, sufficient to more than counterbalance the gain in breeding.

It would be preferable to feed natives well than to grade up and lose the benefit of it by poor feeding. But let the advance be in both breeding and feeding, and good results will follow.—Frank E. Emery, Agriculturist, N. C. Experiment Station.

Rational Stock Feeding.

The Experiment Station is sending out a very valuable bulletin, (No. 106) entitled "Rational Stock Feeding." From the preface it is stated that there are in North Carolina a total of 2,410,576 head of stock of all kinds, valued at $20,850,059, according to the State Auditor's last report. A saving in cost of feeding, placed as low as 15 cents per month, would amount to over $4,000,000 annually. This publication of the Station seeks to show how this saving can be effected. The contents embrace the subjects of the composition and digestibility of food with definition of terms used, feeding standards and how stock rations can be calculated, and some rations fed by practical feeders in the state and others recommended for trial. Among these breeders are Captain B. P. Williamson, W. L. Kennedy, Holt & Homewood, Elias Carr, Jr., Dr. W. R. Capehart, Hackburn & Willetts, and Baron d'Alinge, of the Biltmore estate, all giving valuable experiences. The information given in this publication can not be gotten elsewhere, and all farmers are advised to send for a copy. It is supplied free, as are all publications of the Station.

Rear Calves Only From the Best Cows.

Where a number of cows are milked it will always be noticed that some one is the best of the lot as to the amount of milk produced, or the length of profitable flow, or perhaps in production of

butter. A farmer can probably point out the best cow in the herd, but if he were asked to point out her decendants among the young stock, they might be found few and far below in appearance what might be expected from the dam, or grand-dam. Further inquiry might bring out the information that no male was kept for service on the farm. Also that no good sire could be procured, or that it was too far, or the service fee was too high where a desirable sire was kept. This is a short-sighted policy, and one which the progressive farmer will avoid. Don't use the nearest scrub when time is pressing, but keep a male in your own barn, selected especially to supply the kind of animals you want to have and such as you can take pride in showing your friends. The best way is to patronize the best sires within reach, and go with cash in hand.

All calves from the poorest cows should be killed at once and may be fed out to fowls. Unless you have a surplus of milk and cannot make a good use of it in some other way do not grow up veal calves. Where milk will sell for a fair price the calf will soon eat its head off. Better sell it to the hens for eggs and chicks.—F. E. Emery, Agriculturist, N. C. Experiment Station.

Questions and Replies.

The Station will be glad to extend its usefulness by answering as far as possible questions on agriculturial topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the N. C. Agricultural Experiment Station, Raleigh, N. C. Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station desires in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Tokay Grapes.

Will the Tokay grape vine thrive in this state? If it has not been a success, upon what vine would you advise grafting it?—W. P. S., Southern Pines, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

The Tokay grapes (white and flame colored) belong to Vitis Vinifera, none of which have been perfectly successful in the United States east of the Sierra Nevada, except to some extent in Arizona and New Mexico.

The phylloxera insect destroys their roots, and they are very subject to attacks of mildew. Our native grapes being a "survival of the fittest," resist the phylloxera. There is some hope that now we understand the cause of the failure of the Vinifera section of grapes, we can overcome the difficulty by grafting them on roots of our strongest growing natives, and by the use of spraying mixtures keep down the mildew and succeed in ripening the fruit It is well worth trying and our Station will do something in this line another year.

Value of Manure.

"In an agricultural paper some time ago I saw an article which strongly advocated the feeding of bran to stock. The writer of the paper stated that the value of the manure alone of the animals fed on bran was worth almost as much money as the value of the bran fed to them. I write to ask you if this is correct and shall take it as a favor if you will give me some information of the subject.

Bran at this point is worth a cent a pound. Stable manure (fair quality) $1.00 per load. Do you think that if I were to feed milk cows as much bran as they will eat that their manure will be nearly worth what their feed cost.

I cannot understand how this can be. For instance, if I have a cow which is fairly well fed and which gives, say a couple of gallons of milk a day. I increase her feed giving her as much bran as she will eat. Her manure of course will increase in bulk and will also be richer in fertilizing materials than before, but the flow of milk will also be larger. Part of the bran has gone to form milk, and part of it has passed off as manure. Do you think that the larger quantity and better quality of the manure will nearly repay the extra cost of the increased feed, not counting the value of the extra milk obtained by feeding liberally?"—G. F. O. Oakwoods, N. C.

(Answered by H. B. Battle, Director, N. C. Experiment Station.)

From the results of many experiments the general statement is correct that about 80 per cent, or four-fifths, of the manurial value in the original food can be recovered from the manure if properly taken care of. This does not mean that four-fifths of the value of the food stuff is utilized in this way but refers to the fertilizing ingredients originally present. For example, if the food stuff contains $15.00 worth of fertilizing ingredients in it, then $12.00 worth of these ingredients can be saved. The food stuff itself might be valued at $20 for feeding purposes. Of course, cows and other animals need portions of the food, but they need less of the fertilizing ingredients than they do of the organic portions of the food—for instance—carbohydrates, nitrogen—free extract, protein, fat, etc., and these materials are more needed in the production of milk than the fertilizing ingredients.

Blue Joint Grass.

"Where can I get seed of Blue-joint grass which grows in the West and is referred to in the Patent Office report for 1888?"—S. H. H., Reidsville, N. C.

(Answered by Gerald McCarthy, Botanist, N. C. Experiment Station.)

Blue-joint or Blue-stem grass, Agropyrum glaucum, grows wild on the dry plains of the far west, but the seed is not on the market. It would not do well in this state. It is inferior to many grasses we now have. Bermuda grass is for our climate far more valuable

than Blue-joint. For hay Johnson grass, Tall oat, Tall fescue, and Orchard grasses are all excellent and do well in our state.

Destroying Wild Onions

"Can you give me some remedy for destroying wild onions? They are about to take some of my land."—W R. W. Lewisville, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

The only practicable way to get rid of wild onions is by means of a systematic and short rotation, and the use of smothering crops. Plow the land before any top sets are found, and sow field peas, two bushels per acre. Cut the peas for hay, and chop the land over with a cutaway harrow, and sow in August crimson clover at rate of 15 lbs. per acre, with a thin scattering of winter oats. Cut oats and clover together for hay, and put the land in corn, and follow with winter oats and red clover. By the time this oat crop comes off, the onions will be about gone.

Mixing Fertilizers at Home.

I have been mixing my fertilizers for several years, and have been doing it blindly, not knowing what proportion to use.

1st. I want to know what is the best article I can get to produce phosphoric acid?

2nd. The best article for potash?

3rd. The best article for ammonia, price considered?

4th. What proportions of each to produce the best results?

5th. How high a per cent. of acid phosphate can be made?

6th. How high can guano be made of phosphoric acid, ammonia and potash?

7th. What per cent. of phosphoric acid, ammonia and potash is best for best results for general crops.

8th. I have been mixing—

200 pounds Acid phosphate,
100 pounds Cotton seed meal,
50 pounds Kainit.

What per cent. of phosphoric acid, ammonia and potash have I?—C. S. W. Franklinton.

(Answered by H. B. Battle, Director N. C. Experiment Station.)

I will answer your queries in the order as given.

(1) Acid phosphate is the best material to produce phosphoric acid, considering cost.

(2) The best article to furnish potash for ordinary usages is kainit.

(3) For ammonia, in our locality, cotton seed meal, considering also the cost.

(4) The best proportions found practicable as a general rule are:

1,200 lbs. Acid Phosphate,
600 " Cotton seed meal,
200 " Kainit.

(5) Acid phosphate seldom runs more than 13½ or 14 per cent. available phosphoric acid. It should always be bought upon a definite guarantee, as any percentage can be made less than that amount according to the grade of the rock from which it is produced.

(6) It will depend entirely upon what ingredients are used as to the percentages of the three ingredients, phosphoric acid, potash, and ammonia in the mixture. If a high ammoniating material is used, of course a high percentage can be procured; likewise the same of potash. The trucking fertilizers often run from 6 to 7 per cent. available phosphoric acid, 6 to 7 per cent. of ammonia, and 8 to 10 per cent. of potash. These can be changed according to the quantity of the different ingredients used.

(7) For average purposes for cotton and corn, the percentages given by the above mixture are about right, namely 8.55 per cent. available phosphoric acid, 2.55 per cent. ammonia, 1.68 per cent. potash.

(8) The proportions used by you, namely:

200 lbs. Acid Phosphate, 13 per cent.
100 " Cotton seed meal,
50 " Kainit

are useful. The percentages given by the mixture would be 8.14 per cent. available, 2.42 ammonia, and 1.96 potash. The proportions are so close to the above amounts that if you have found the mixture useful I see no reason to advise a change. I send Bulletin No. 95, in which you will find many references to the composition of fertilizing iugredients and their use in mixed fertilizers.

Asiatic Pears.

There is a nursery firm at Thomasville, Ga., who claim to raise pears from what they call Asiatic stock or from a kind of pear of Asiatic or Chinese origin: that the Le Conte and Kieffer pears are of this class and that they will not blight like those of European origin. Is there anything in their claims?—W. E. W., Avilla. N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

The Kieffer and Le Conte pears can probably be claimed to be of Asiatic origin. Not that they came from Asia, but they are seedlings from the Chinese sand pear, crossed with one of our old sorts. It is generally thought that the Kieffer is a cross of the Chinese sana pear and the Bartlett. But so far as we can ascertain, nothing is certainly known of their origin, save that they were grown from seed of the Chinese sand pear, which was evidently accidentally erossed with something better. The Kieffer resembles the Bartlett in shape. The Le Conte is now quite commonly used as a stock for grafting other pears upon, and from its vigorous habits, and the ease with which the stocks can be raised in the south will probably be a popular stock for pears in the future. But that working a pear on the Le Conte stock makes it blight proof is all nonsense. The Le Conte does seem itself to be less liable to blight, but no pear is exempt from it in this country, though some blight worse than others. The great vigor of the Le Conte stock may make the trees grow, or better able to recover from an attack, but it will not give them immunity.

THE EXPERIMENT STATION

AT RALEIGH, NORTH CAROLINA.

Fertilizer Analysis for 1895—Hog Cholera, Cotton Seed Feed, Ox Warble Fly. Read Questions and Replies.

February 1895.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. They are specially prepared to be serviceable as far as possible to the practical farmer. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefitted please do not apply for them as we have none to throw away. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Fertilizer Analysis for 1895.

A bulletin has already been issued by the experiment station (No. 111) which gives in detail the standing of all fertilizer brands on sale in North Carolina in 1894, as determined by analyses of samples taken by official inspectors. This bulletin is issued in advance of the new analyses which are issued every two weeks during the season of 1895. The first of these bi-weekly analyses will appear on Feb. 16, 1895. A special application is needed for this series. Apply to Dr. H. B. Battle, Director, Raleigh, N. C.

The valuations of the unmixed ingredients at the seaboard have been fixed at 4½ cents per pound for available phosphoric acid, 14 cents per pound for ammonia, and 5 cents per pound for potash. The phosphoric acid is rated one-half cent lower and ammonia one cent per pound lower than for past seasons. The reprinted analyses of 1894 are calculated on the new basis of valuations.

Hog Cholera.

A correspondent writes: "Could you give me anything that will prevent *hog cholera*, or that we could use as a cure? Great numbers of hogs are dying here with it daily. Please tell me if there is any remedy or even a preventive." The answer to this in substance was: There are preventive measures which may be used and which may ward off the disease in a large number of cases. Indeed, some breeders claim to be able to cure cholera if they can get to the animals before the appetite is gone, but not after food is refused. This remedy or preventive is carbolic acid. How little will protect, or how much the patient can bear I am not informed, but about 10 drops would be a dose for an adult and less for younger swine.

The better way to feed and administer medicine with food would be to prepare all food immediately before feeding, stir in as much medicine as needed for the pigs being fed. Then clean up and disinfect afterward. Clean up all foul places to which pigs have access. Keep sleeping places warm and dry. Try to prevent buzzards from visiting pig runs and feeding places. Bury the dead, or better cremate dead bodies, and disinfect with carbolic or bichloride solutions or with a cheap solution made by suspending a coarse bag containing 20 pounds copperas, (sulphate of iron) in a barrel of soft water. After a little time the solution can be used as wanted and more water added until the copperas is gone from the bag.

The health of the pig may be promoted by keeping a mixture, made as follows, where the pigs can get it at will: 1 peck hard wood ashes; 1 pint salt, 1 peck charcoal. This recipe might be extended by adding ½ lb. sulphur, ½ lb. black antimony and 2 lbs. sulphate of iron, pulverized.

Great dependence should be placed on prompt destruction of dead bodies and proper disinfection immediately afterward, accompanied by the administration of carbolic acid with this mixture kept where pigs can eat it if they are inclined to do so.—F. E. Emery, Agriculturist, N. C. Experiment Station.

The Ox-Warble or Heel Fly.

One of the most destructive pests of domestic animals is the ox-warble or bot fly, *hypoderma lineata*. This parasite, while probably not very painful to the animal infested, is expensive to the owner of the animal since hides or skins showing warble holes are docked one-third of their value. The presence of the maggots further decreases the amount and quality of the animal's flesh so that on the average, for a two year-old steer, the loss is apt to be above $10 or $12.

The fly which causes this damage is about the size of and very much resembles a honey bee. It deposits its eggs in spring, during the period of shedding of hair, on the legs, tail and belly of cattle, preferably yearlings. By licking these parts the eggs are taken into the animal's gullet where the mag-

got hatches and clings to the walls. It soon bores into the tissues and eventually—during the succeeding fall or winter—finds its way to the animal's back where it forms a tumor just beneath the skin. Here it rests for some time and completes its growth as a maggot. Each tumor, if closely examined, will show a small pore through which the maggot obtains air. When full grown the maggot enlarges this pore and through it comes out and drops to the ground into which it enters and remains dormant as a *pupa* for about six weeks. It then comes forth as a perfect fly to lay its eggs as before.

REMEDIES.—During the period of hair shedding, horned cattle should have the tail, belly and legs—especially the parts just above the hoofs—rubbed two or three times a week with a mixture of kerosene or fish oil and powdered sulphur. In January and February the backs of cattle should be carefully examined for the tumors which are readily seen or felt just beneath the skin and the enclosed maggot squeezed out and killed. A little crude carbolic acid or mercurial ointment should be then rubbed on the spot. If the maggot can not be squeezed out the oil or ointment should be well rubbed in so as to close up the breaking pore in the tumor thus smothering the maggot.

The warble fly is not a great traveller and if all the maggots infesting cattle on any farm are killed in January or February that farm will be nearly or quite free from the parasite for some years unless introduced with new stock. Killing the maggots in the tumors is the easiest and surest way of getting rid of this expensive intruder. Gerald McCarthy, N. C. Experiment Station.

How Relative Values Per Ton are Calculated for Fertilizers and How They Can Be Utilized by Farmers.

It may be of interest to some to know how ton values are calculated, using the seaboard valuations for the unmixed constituents of a fertilizer. The amount or percentage of either of these constituents present in the fertilizers is given by the analysis. This represents parts per 100. The percentage is accordingly multiplied by the valuation per pound to get value per 100 pounds. This is now multiplied by 20 to determine the value per ton (2,000 pounds). This is done for all three constituents, and the three amounts are added together to arrive at the value per ton.

The following is an example:

Percentage or lbs per 100.	Per 100 lbs.	Per ton
9.64 Available Phos. Acid at 4½c per lb.	$0.4338	$8.68
2.36 Ammonia at 14c per lb.	.3346	6.69
3.05 Potash at 5c per lb.	.1525	3.05
Total value	$0.9209	$18.42

The value per ton as here given represents the market price per ton at the seaboard of the unmixed ingredients. For interior points, railroad freights to those points must be added.

The values per ton represent unmixed ingredients. They show what would be the approximate cost of the ingredients to a farmer in case he bought them himself for mixing. The cost is, as stated, on the basis of cash in small lots (less than five tons) in bags, at the seaboard. By a comparison of these values as given by the Experiment Station, a farmer can see how much he is being charged over and above the actual cost of the raw materials. The manufacturer in addition has to allow for mixing the ingredients, branding the bags, handling, fixed charges, agent's commissions, profits, etc., together with freight to the interior point. The cost of mixing, sacking and branding the bags will not vary greatly from $2.60 per ton.

Considering all items, the price of a mixed ammoniated fertilizer at an interior town, ought not to be more than 25 to 33⅓ per cent. greater than the relative seaboard value per ton of ingredients as given in the tables found by analysis, with, of course, the freight from the seaboard to the interior point added.—H. B. Battle, N. C. Experiment Station.

Cotton Seed Feed.

A correspondent (R. N. P.—Reidsville, N. C.) writes: Will you kindly write me your opinion in regard to the value of "cotton seed feed" as prepared at the mills as an economical food compared with other foods raised on the farm? Do you think it will do to feed it to horses and mules?

Cotton seed meal is one of the most valuable and cheapest foods for stock we have on the market. It is now being fed in small quantities to the Station's mules but is not being relished by them.

Cotton seed hulls are a course food containing little digestible matter. They are, however, an excellent medium for dividing fine meal in the animal stomach. Please note pages 423 to 426 of Bulletin 109 which bears directly on your question.

See also articles II to V in Bulletin 81. The digestibility of cotton seed hulls as laid down in the latter has been reduced by later work. "Cotton seed feed" of the mills corresponds nearly to rations numbered 3 and 4, page 421 of Bulletin 109 (approximately 5 lbs. hulls to 1 lb. meal).

Their use for stock depends on price of straw and its preparation. With straw or corn stalks on hand, no one can afford to waste either to buy hulls

ready mixed with meal. It will pay farmers as well to follow Bulletin 104 in saving stalks and thus mix their own feed as cotton "seed feed" pays the oil mill men.

Our cotton seed feed rations contained the following amounts of digestible nutrients per ton of food:

	Protein	Carbohydrates	Fat	Ratio	Heat Equivalents
Cotton seed hulls	4.88	646.40	46.40	106.6	756.6
Cotton seed meal	681.00	430.60	183.80		1528.8
Cotton seed hulls 7 to 1 of meal	75.12	632.20	19.94	10.8	752.6
Cotton seed hulls 6 to 1 of meal (3)	83.33	658.44	65.14	9.71	889.6
Cotton seed hulls 4 to 1 of meal (4)	120.50	731.04	67.60	7.52	1005.0
Cotton seed hulls 3 to 1 of meal	156.25	720.60	82.70	5.89	1064.6
Cotton seed hulls 2.8 to 1 of meal	165.26	651.90	81.63	5.13	1002.5
Cotton seed hulls 2.4 to 1 of meal	176.59	647.70	84.97	4.88	1017.2
Cotton seed hulls 2 to 1 of meal	203.70	642.13	88.27	4.27	1046.2
Whole raw cotton seed	196.60	558.40	337.60	7.13	1521.4
Whole roasted cotton seed	157.20	581.80	322.20	9.19	1464.4
Crimson clover Hay	210.00	826.20	17.96	3.76	1077.7
Corn meal	106.40	1183.20	72.20	14.02	1453.5

The crimsom clover hay and corn meal are added to compare with these rations.

The heat equivalent is obtained by adding to the sum of the carbohydrate and protein 2.27 times the fat.—F. E. Emery, Agriculturist, N. C. Experiment Station.

Questions and Replies.

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Influence of the Moon.

The people here in my country are governed by the moon in nearly all things they do. They even will not make kraut, nor the old women will not make soap unless the sign is right. Hogs must be slaughtered or colts weaned according to the moon. Please give me any information or cite me to literature upon the above subject.—Dr. C. H. L. Farmers, N. C.

(Answered by H. B. Battle, Director N. C. Experiment Station.)

The belief that the moon has some effect upon the growth of crops and various other deeds of men is widespread in certain regions. There can be no reasonable cla' n that the moon does really influence any thing upon the earth in this way, and such traditions doubtless have descended from our ancestors, who thought very much more of natural objects and their possible effect upon their actions than we in this day. Doubtless one reason why this idea obtained credence is that formerly those who considered such to be the case were very observant and very careful in their work, and hence necessarily were more successful; such being the case they believed more than before as to the cause of their success and telling others of it caused them also to become firm believers.

To give an illustration of this belief, one part of the country may think that a certain phase of the moon indicates dry weather, whereas in other parts of the country, others may believe that it portends wet weather, or these beliefs may be entertained by different parties in the same region. Of course it is impossible for these various results to occur at the same place and at the same time.

Feeding Cotton-Seed Products.

A short time ago I received from the cotton oil company a circular showing the protein and fat constituents of fifty American feeding materials, with their rank in feeding value, etc. If their report is correct we cattle feeders are not feeding the proper feeds to make weight. I am feeding twenty-two steers of 1,000 pounds weight this winter. Here is what they are being fed. I would be pleased to have your opinion on it. The first two weeks I had ground together corn and wheat, one bushel of each, and now take two bushels corn and one bushel wheat. Give them two and a half bushels of this on top of eight bushels smooth wheat chaff in the morning, then all the cut corn fodder (stover?) they will eat. At noon two and a half bushels mixture with the chaff and in the evening two and a half bushels mixture, as before, with chaff followed by as much cut corn fodder as they will eat. Access to water twice a day. All are dehorned and loose. I herewith enclose the small circular with rank of feeding values. Would also like to have your opinion of the cotton seed meal and hull business. If it is as good as they say, it would pay to use it. Corn is worth here 45 cents per bushel; wheat, 54 cents; oil meal $24 per ton; gluten meal $20 per ton; cotton seed meal about $21, and cotton seed hulls $9.10. If you have the time and will give me your

opinion on how I can make the most gain on these steers I certainly will be greatly obliged. J. A. E., York Pa.

(Answered by F. E. Emery, Agriculturist N. C. Experiment Station.)

I find there is some misrepresentation in the circular. For instance, the figures given for cotton seed meal and hulls are the extreme highest ones found in a large number of analyses. They represent composition and not digestibility—two very different considerations. Please consult table I pp 285—6, Bulletin 106 North Carolina Experiment Station on this question.

You can not go far wrong feeding a good grain ration with coarse by-products made on the farm. Your corn fodder (I believe it has had the ears husked out of it and is called *stover* to distinguish it from that grown thick and not allowed to produce ears) is better than cotton seed hulls. Your wheat chaff is also worth more than the hulls. Make your own comparisons as to price.

Now for your ration. It is too wide in the ratio of protein to carbohydrates. I would not advise you to change your proportion of two of corn to one of wheat but to feed only 200 pounds of it per day mixed with 100 pounds of cotton seed meal. Feed this on the chaff as before and give stover the same, all the steers will eat twice daily. I have assumed that this chaff weighs 6¼ pounds per bushel, making 150 pounds daily and that the steers would eat 250 pounds of stover daily. This ration would be about the standard for 1,000 pounds live weight. It requires 235 lbs. less of corn and wheat mixture per day; or putting the 100 pounds of cotton seed meal in place of 100 of the mixture saves 135 pounds per day and the steers are being fed a fattening ration. Even if this does not seem to be increasing their weight so fast, it ought to make flesh at a cheaper rate per pound, hence a more profitable ration.

The change from mixture of corn and wheat 1 to 1 to 2 of corn to 1 of wheat only changes the protein 0.8 pound, the carbohydrates 0.6 pound and fat 0.76 pound per day in the whole ration for 22 steers. It is, however, a change in the right direction from 2d to 3d fattening period. Two of corn to one of wheat for first and third periods and 1 to 1 for second would be a good formula with the other articles as fed to above steers.

Top Dressing for Clover.

Please write me what you think the best thing to top-dress red clover in the absence of stable manure. Wish to take cost into consideration. Can you tell me what is best to sow in and around fish ponds for carp to feed upon, and where I can get the seed?—H. F. F., Taylor, N. C.

(Answered by H. B. Battle, Director, N. C. Experiment Station.)

A good top-dressing for clover would be 100 pounds acid phosphate 100 pounds kainit to the acre. Acid phosphate contains plaster, which is of material benefit to clover, besides the phosphoric acid it contains; potash in kainit is a useful addition also. Our Botanist, Mr. McCarthy, recommends the following to be planted around fish ponds for carp: "Good plants for fish ponds are the following:

Wild Rice.................. *Zizania aquatica*
White Water Lily.......... *Nymphea odorota*
Yellow Pond Lily.............. *Nuphar advena*
Pickerel Weed............ *Pontederia cordata*.

Seeds of the above can probably be obtained from any of the large seedsmen. All the above are native to this state, very prolific and hardy rapid growers and favorite food for fishes wherever they occur."

Building a Silo.

I want to build a silo out of brick. I would like to know if it would do built of bricks. How is it built and would common mortar do to build it with or would it have to be cement? The place I want to build it on is high ground, against my barn. How do you put the feed in and do you salt it?—R. B. F., Durham, N. C.

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

I have seen a brick silo in the ground like a well which kept the silage very well. The trouble with a below ground silo is the cost of excavating, while a brick wall above ground strong enough to resist the pressure at filling, would probably cost too much. Your attention is called to the plans illustrated in Bulletin No. 80 of this Station. The round form is the best. A steel silo can now be purchased which would last a life time.

Feed is cut ⅜ to 1¼ or even 2 or 3 inches long and run up into the silo on a carrier attached to the cutting machine. If the ground is high and you can drive on the uphill side it will be best to do that; set the machine so the silage will fall into the silo and dispense with the carrier. No salt is used. Simply keep the top leveled and tread the sides and soft places in filling so it will settle even.

Cutting Oats for Feed.

Please let me know which would be the better way to cut oats for feed; to cut them in a tough state while straw is green or wait until ripe. I want them to feed as hay and am under the impression to cut them green would be best.—S. J. B., Granite Hill. N. C.

(Answered by F. E. Emery, Agriculturist N. C. Experiment Station.)

Oats cut while yet early in the milk stage will be best for hay, as the valuable food compounds will then be largely distributed in the leaves and stems. If left later the movement of these compounds to the grain carries much from those parts which remain comparatively valueless straw, while the nourishment of the crop is largely concentrated in the kernels.

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ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

RALEIGH, N. C.

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RECENT BULLETINS OF THE N. C. AGRICULTURAL EXPERIMENT STATION.

Bulletins will be sent to addresses in North Carolina free of charge. To parties outside of the State, a small fee of 4 cents each (10 cents each for Nos. 73, 92 and 112) is charged, or 25 cents per year. Only a limited number can be sent to each address, and the Station therefore must request parties to confine their applications to actual needs. Apply to Dr. H. B. BATTLE, Director, Raleigh, N. C.

MILK RECORDS AND TESTS.

I. MILK RECORDS AT THE EXPERIMENT FARM.
II. VARIATIONS OF MILK-YIELD CAUSED BY VARIATIONS IN MILKING.
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BY F. E. EMERY, AGRICULTURIST.

I. MILK RECORDS AT THE EXPERIMENT FARM.

When this record began in 1891, the Experiment Station had four cows in its stable, one a registered Jersey, one unregistered, and one grade, the fourth belonged to the A. and M. College. The registered cow was stripping and the unregistered one had been milking about three months, having come in milk prematurely by an injury which resulted in permanent lameness. It was doubtless a broken femur or thigh bone.

The beginning of lactation for the grade cow was the signal for beginning to weigh the milk. Weighing was at first done on the Fairbank's scales used to weigh food for the cows. Record papers, to last one week, were ruled leaving a column for each cow whose milk was to be weighed. In each column, spaces were left for recording the weights of the morning and night's milk for each day of the week.

Later, a Chatillon spring balance was purchased on which to weigh the milk and also the grain food for the cows, and for greater convenience weekly blanks were ruled with printed headings. These require much less work to keep the record. Last of all we adopted the Chatillon Spring Balance* graduated to tenths and twentieths or five-hundredths pounds instead of ounces. This greatly facilitates the work of addition and subtraction, and is much simpler than using ounces, besides freeing the record from liabilities to mistake in using the fractional numbers.

Chatillon Spring Balance.

There are two pointers on this scale, one is movable to be set to take out pail-tare without subtracting. In order to take advantage of this convenience, make all milk pails weigh alike by addition of solder to their bottoms.

The weekly records are copied into a book made specially to hold a year's record of one cow on one page. It has one column for each month with dates in the margin and the weights of morning and evening milk for each day are added and entered as the yield per day for each cow. The right hand page is

*Sold by Borden & Selleck, Chicago, Ill. Price $4.

left for notes or observations on the cow or records of feed and other important items.

This record has been kept for a little more than four years. As to the number of cows in milk at any one time quite a large number have been tried and not accepted, or purchased and milked until fat, then turned off for beef where they proved to be unfit to keep for milk and butter.

No high prices have been paid for cows, and our object has been to buy such as any private dairyman might select, to test them as he should do, and to dispose of them in such a way as to gain some profit on each animal. This can be done by feeding sufficiently to fatten the poorest milkers when the beef value together with milk obtained will cause all but the poorest to yield a small net return. Several examples are given below.

Cows are often held by dealers at fictitious prices. They are usually priced upon the individual appearance and by the amount of milk in gallons that has been, or that the dealer may claim each individual capable of giving. Their real worth to any dairyman is of course based on what yields he can secure with his methods of feeding and handling. Appearances are often deceitful and good judges of the "looks" and "marks" of a good cow, as fine horns, yellow ears, loose hide, open chine, large cord-like muscle front of stifle, or knee joint, large udder and milk veins or fine escutcheon with long or short tail, wedge shaped, may fail to point out the profitable cow. The crucial test is daily application of scales and test of milk for fat.

In commencing this record there were four cows at the Station barn. In adding to that number, our aim has been to select as good ones as we could secure and for which the price would not over balance the value of the animal. The plan adopted was to secure a herd a little above the average, yet no better than any dairyman of small means can obtain. So many have been examined and discarded, or kept a few days on trial and removed, that it seems certain that cows offered generally for sale rank far below those for which records are given below.

Milk Record for 1891.

Below will be found the milk record for each cow with name and breed, during the year 1891.

Name of Cow.	Breed.	Milk Yield within the year 1891. LBS.	Milk Yield for one year from calving. LBS.
Trixey Green	Grade Jersey	3429.	3436.*a*
Dora McKee	Jersey	2535.*b*	
Lapham or College cow	Native	2388.*c*	
Old White	Mountain Native	3605.*d*	
Daisy	Grade Jersey	4434.3*e*	
Repsey	Grade Jersey	3091.45*f*	
Devon	Devon	1165.8*g*	

Notes on the Record for 1891.—a Record for eleven months during one period of lactation.

b Came in milk prematurely in August, 1890, and with broken femur. No record was made of first three months.

c Five months and twenty-three days record.

d Nine months and twenty-three days.

e Seven months and thirteen days.

f Six days less than eight months.

g Three months and twenty-two days.

MILK RECORD FOR 1892.

In the table below is found the name and breed of cow with her milk record during 1892.

NAME OF COW.	BREED.	Weight of cow near close of year. LBS.	Milk yield within the year 1892.	Milk yield for one year from calving. LBS.
Trixy Green	Grade Jersey	922.	1899.[1]	3014.
Dora McKee	Jersey	837	4141.[2]	4467.6[3]
Devon	Devon	872.	582.7[4]	
Nellie	Grade Jersey	------	1157.8[5]	
Jersey Guernsey	Cross-bred	989.	2691.8[6]	
No. 1	Grade cow	------	418.[7]	
No. 2	Grade Jersey	830.	3063.6[8]	3274.7[9]
No. 3	Grade Jersey	1016	2707.8[10]	
No. 4	Native	------	5.[11]	
No. 7	Native	875	2786.7[12]	
No. 5	Native	944	2393.[13]	
No. 6	Native	------	2629.81[14]	
No. 8		------	76.25[15]	
No. 9		------	9.7[16]	
No. 10	Mountain cow	752	484.98[17]	
Miss Jones	Native	622	1263.[18]	
Jones 2d	Native	826	279.1[19]	
Shep	Native	751	1626.[20]	
Charcoal	Native	------	1203.4[21]	
Miss Haley	Native	635.	1403.4[22]	
Spot	Grade Jersey	698.	1407.7[23]	

Notes on the Record for 1892.—1. Dry 61 days last of year; seemed to have some nervous affection in January, which cut down the yield of milk and nearly dried off in May, but cow kept in good order after it. 2. Dry 55 days; lactation began in February, and record 10 months. 3. For year from calving, the record includes January and February of 1893. 4. Yield for 2 months and 4 days. 5. Yield for 4 months and 21 days. 6. Milked 8 months and 22 days; this cow is nervous and excitable; she is a bad kicker, but her milk is rich; she early became master of the yard, and was dehorned on June 30th; milked 9 months, less 7 days. 7. Milked but 23 days. 8. Grade Jersey was poor and weak; was a fit subject for a veterina-

rian when she came to us, at the beginning of her lactation, in February. 9. Milked for a full year, less 6 days. 10. Grade Jersey milking from only two teats, and milked 9 months and 20 days. 11. Milked only twice. 12. Hornless brindled native or grade; milked but 6 months and 19 days 13. Hornless native; milked 7½ months. 14. Native; milked 5 months and 8 days, and sold. 15. Milked 8 days only. 16. Milked 5 days. 17. Milked 25 days. 18. Milked 3 months and 20 days last of 1892. 19. Milked 66 days when fresh. 20. Milked 8 months and 18 days. 21. Milked 3 months and 21 days. 22. Milked 3 months and 9 days. 23. Milked 2 months and 28 days.

Milk Record for 1893.

Below is given the name, breed of cow, and weight, with the total yield of milk during the year 1893:

Name of Cow.	Breed of Cow.	Weight of cow. Pounds.	Milk yield within the year 1893. Pounds.	Estimated yields of butter within the year 1893. Pounds.
Dora McKee	Jersey	846.	2751.	212.86
No. 2	Grade Jersey	837.	3008.	176.90
No. 3	Grade Jersey	1062.	1004.	61.26
No. 5	Native?	832.	6607.	297.75
No. 7	Native	882.	3944.	220.43
Jersey Guernsey	Cross-bred	853.	5213.	290.49
Spot	Grade Jersey	809.	4337.	263.4
Miss Haley	Native	752.	3152.	188.38
Miss Jones	Native	683.	4118.	167.7
Devon	Registered	940.	493.	30.0
Hubbard	Native	795.	461.6	26.8
No. 14	Jersey	859.	3345.6	194.75
No. 15	Grade Jersey	756.	1198.7	66.7
Daisy	Mountain cow	893.	1121.	59.81

Notes on the Milk Record for 1893.—In addition to the weight of cow and yield of milk in pounds, a test has been made and the amount of butter fat calculated for each month. This has been calculated as butter of 85 per cent. pure fat, and 15 per cent. water, salt and impurities. If the butter contains a little higher than 15 per cent. water, etc., it will be partially balanced by losses in skim and butter milk and manipulation.

The average weight of cows, were compiled for this record from the monthly weighings for the full year.

Dora McKee.—Lactation began last of February, 1892, and again in April, 1893, without having dried off in the meantime. Previous to calving this cow was dry 55 days. During the year 1892 she yielded 4141 pounds of milk. In 1893, not having had any resting period, she gave but 2751 pounds. Milkers were changed twice and cows had less pasturage in 1893 than in 1892. This may be cited

perhaps as a case showing it is not profitable to encourage the continuous milking habit. This record shows with preceding ones what we have previously observed, that cows have off years and should be judged carefully lest a good one be discarded when tested during a period of depression.

No. 2.—Began lactation out in the woods during cold weather in 1892, and came to us weak and emaciated. She gave 3063 pounds milk in 10 months and 5 days. In 1893, she was sick with milk fever five days after calving. Was back in the stable after five more days, but gave only 3008. pounds of milk in 10 months and 2 days, but 1½ months was on the last part of lactation for previous year. Was dry nearly two months. Became master of the herd and was dehorned Dec. 12th to reduce her fierceness. The butter yield from this cow has been disappointing.

No. 3—Large grade Jersey. Milk all from rear teats. Yield too small to support cow and she was sold for beef two months after beginning of lactation. Yield is for 53 days last end, and 56 days of next period of lactation, with 43 days dry between.

No. 7—Brindled, polled, dry nearly half month in April.

No. 5—Red, polled, largest yield of milk, but per cent. of fat rather low. Dry about 25 days first part of year.

GUERNSEY JERSEY—Dry 4½ months, 77 days of which came into 1894. Milked 10 months, 12 days.

SPOT—Grade Jersey. Milked three months with first calf before this year began. Dry October, December, 60 days, and year completed with fresh lactation.

MISS HALEY—Native. Raised because her dam was a good cow, and sold because her fence-breaking mischievousness could not be tolerated. Purchased to mate Spot above, and came in milk about two weeks earlier, and failed to breed with several trials, so has milked continuously all the year. These two heifers are in contrast for dairy use. See article elsewhere. Miss Haley was a fierce master of heifer yard, and was dehorned with Jersey-Guernsey June 30, 1892, 2½ months before lactation began.

MISS JONES—Small black cow. Was milking when purchased, and gave a very uniform amount for over a year. Was giving as much when an injury to her side caused her to be sent to the butcher. Milked 8 months and 18 days in 1894.

DEVON—This registered cow came to State Fair fresh in milk and was sold for a milch cow, but not proving satisfactory, was sold here to prepare for beef. Was milked 60 days for record.

No. 14—This cow was taken on trial June 20th with calf by her side and purchased. Calf returned to seller. She was "hipped," which accident was probably due to fierceness of No. 2. Record for 6 months 10½ days.

No. 15—Cow on trial at first, then kept for milk until owner could dispose of her. Milked 3 months and 22 days.

DAISY—Mountain cow, probably a shorthorn. Fed and milked

here by owner because cow is not contented alone. Record for 56½ days. Excrement given for stabling.

Feeding the Cows.--It is very important to consider the feeding when the milk record of a cow or herd is being examined. In case of the above record, every animal was fed all it would eat every day. The food was alike for all during the entire time, except when yielding a large amount of milk the grain-ration was given more freely. All being thus fed, the yields are fairly comparable and show, as well as such average yields can, the differences in value of the cows, making some allowances for not being in most vigorous condition at times. The feeds used have been corn silage, four months; bagasse silage, half a month; hay and cotton-seed hulls, and green rye, oats and Canada pease, cow pease, and green corn or clover. The grain-ration has been mainly a mixture of wheat bran and cotton-seed meal, mixed in the proportion of two of the former to one of the latter.

Dry cows have been fed bran alone, or when fattening upon cotton-seed meal alone. In whatever proportions feeding has been done, every animal is given as much as it seems able to eat, and reductions are made when they begin to leave much waste.

Water.—Cows have had an abundant supply of pure water from a tank in which rainfall on the barn has been collected. They have been offered water twice daily when confined and at other times left in yard for several hours each day with access to water from tank. Water has been offered three times daily during hot weather, and when on dry pasture, as during 1893, when the pasture lot was not supplied with water.

Milk Record for 1894.

In presenting this summary, it should be stated that of the cows reported in the record for 1893, from the effects of abortion, two have died and one other rendered worthless for comparisons. Besides these cows, there have been milked at the Experiment Farm during the year three others, for periods ranging from three to four months.

Abortion in the herd has greatly interfered with a regular flow of milk. Cows which have been affected by this disease in 1894 are, No. 2, Spot, Daisy E, Trixy's Rioter, and the three that are dropped from record, Guernsey-Jersey, No. 14, and Miss Haley.

Epizootic abortion is a disease of the envelopes immediately surrounding the fœtus and within the womb of the cow. Sometimes it is found in the calf itself, but never attacking the cow. It has been investigated in France by Dr. Nocard. He proved the bacterial character of the disease and suggested the treatment that bears his name. The treatment has been more recently simplified by omitting injections. There should be thorough cleaning up and disinfection of all parts of the stable and yards. This is accomplished by cleaning out every nook and corner, digging up the earth floors of sheds, stalls, etc., to the depth of three inches and refilling with fresh clay, after a thorough sprinkling with copper sulphate (blue stone)

MILK RECORD FOR 1894.

		No. 2.	No. 5.	No. 7.	Spot.	Dora McKee.	Trixy's Rioter.	No. 18.	No. 19.	Polly B.	Daisy E.	Fannie of Sedgefield.
Least weight for year	Month	Aug.	Feb.	Aug.	March.	Aug.	April.	March.	March.	Feb.	May.	Nov.
	Weight in lbs	821.	837.	967.	761.	747.	565.	724.	739.	471.	931.	641.
Greatest weight	Month	Dec.	Nov.	May.	July.	April.	Dec.	Dec.	Dec.	Dec.	June.	Dec.
	Weight in lbs	973.	984.	1065.	908.	930.	734.	848.	841.	592.	1043.	651.
Average weight for year in pounds		884.	908.	1022.	844.	841.	639.	789.	789.	525.	966.	645.
Record began		Jan. 1.	Jan. 1.	Jan. 1.	Jan. 1.	Jan. 1.	Jan. 15.	M'ch 6.	M'ch 21.	Feb. 16.	Jan. 1.	Oct. 27.
Record closed		Dec. 31.	Dec. 31	Dec. 31.	Dec. 31.	Dec. 31.	Dec. 31.	Dec. 31.	Dec. 31.	Dec 31.	Dec. 31.	Dec. 31.
Yield of milk in 1894—pounds		3872.1	4506.3	3918.	6175.2	3315.5	2565.7	3949.5	3897.8	3338.2	5486.5	1165.95
Number of days dry		00.	52.	115.	00.	24.	00.*	00.	00.	00.*	6.	
Average per cent. of fat in milk		5.015	4.07	4.44	4.71	6.42	5.304	5.60	5.97	5.65	3.90	5.188
Total butter fat from monthly tests, in pounds		197.24	205.95	180.74	297.45	212.76	143.907	230.63	228.014	181.76	218 46	61.82
Calculated yield of butter at 85 per cent., in pounds		232.04	242.29	212.64	350.53	250.30	169.36	271.32	268.25	213.83	257.23	72.73
Calculated yield at 80 per cent. fat, in pounds		246.55	257.44	225.92	371.81	265.70	179.88	288.29	285.02	227.2	273 07	77.27

*Not dry after coming into milk.

solution in the proportion of 40 grams per litre, or 6.4 ounces per gallon of water. This sprinkling is recommended to be done every ten days, and should extend to the rubbing places as well as floor. This was at first faithfully done, but was discontinued after warm weather was past.

The treatment consisted in daily sponging the cows about the tail, vulva, and adjoining parts with the following solution: Distilled soft rain water $4\frac{1}{2}$ gallons; glycerine and 36° alcohol, $3\frac{1}{4}$ ounces each; bichloride of mercury $2\frac{1}{2}$ drachms. This solution has been in use at this writing over 15 months, and it will be continued until it seems plain there are to be no more abortions. More than one year has passed since the last one occurred, and most of the cows are due to calve from August, 1895, to January, 1896.

Notes on the Record for 1894—Cow No. 2 came in milk April, 1893. and should have been fresh again in June, but was attacked by abortion March 4th, 1894, and continued yielding milk throughout the year.

Cow No. 5—Aborted October 22d, 1893, and continued milking until October, 1894. Dry 52 days and brought twin calves by Seneca, American Shorthorn Herd Book, No. 110,166, November 17, 1894.

Cow No. 7—Dried off Middle of February and came in fresh June 9th, having been dry nearly four months.

SPOT—After beginning lactation November 29th, 1893, milked steadily to September 24th, 1894, when cow came fresh in milk again by abortion and continued in milk throughout the year.

GUERNSEY-JERSEY—Milked until February 19th, when she dried off. Aborted and died in March bringing twin calves.

MISS HALEY—Sold for beef March 21, 1894.

Cow No. 14—Dried off March 21st. Died from shock of abortion. This was the cause, but the cow was weakened by presence of foreign matter in lungs which prevented proper circulation of air and aeration of blood.

DAISY E—Fresh in November, 1893, and aborted August, 1894, after having ceased milking six days.

TRIXY'S RIOTER—This heifer was bred at Experiment Farm. Her dam was Trixy Green, whose record has been published. We were told she was a descendant of a cow that wore the wreath at the May Fair for several years, but later have ascertained that she was an inbred Bismarck of Torrington cow, out of Nellie Bismarck by Prince, whose dam was a grade cow. According to this she carried 50 per cent. of blood of Bismarck of T., 25 per cent. of Muriel, and 25 per cent. of a grade Jersey cow. She was a neat looking, small cow, but of only small capacity. Bred to Thornbrook's Rioter 16592. Trixy Green produced Trixy's Rioter. This heifer began lactation January 9, 1894, at nearly $2\frac{1}{4}$ years of age, was afflicted by abortion in September, 1894, and has yielded 2565.7 pounds of milk, averaging 5.30 per cent. fat. Was not dry after coming in milk during the year.

POLLY B.—A full Jersey belonging to Mr. T. Henry Briggs, Raleigh, N. C. Mr. Briggs offered the use of this heifer through two milking periods to be returned to him at the beginning of the third period. Polly was received January 17th, 1894, and came into milk February 12th, 1894 at about two years and two weeks old. She is under average size for a two year old, and will be given a long first period followed by a shorter second period in order to give her a better chance for growth.

No. 18.—Grade Jersey cow purchased with the next to replace *Guernsey Jersey* and *No. 14.* Cow came to the farm nearly fresh in milk, the young calf having been recently taken away from dam. This cow has given a low percentage of fat in milk when milked before feeding.

No. 19.—Cow came to Experiment Farm March 21st, when she had been milked with calf by side for about 10 weeks.

Fannie of Sedgefield.—Cross-bred Guernsey Jersey sired by registered Guernsey Squire of Salem, 1451; dam registered Jersey cow, Fred's Pet, 20932. Bred at Sedgefield Stock Farm, Winston, N. C. Purchased of Mr. Elliott Warren at close of the State Fair. Fannie came into milk immediately and gave a full two month's record before the year was out, having produced her first calf at 1 year 11 months and 2 days old.

Feeding has not varied very much from that of 1893 except in summer. The winter ration consisted mainly of a meal ration of one part by weight of cotton-seed meal to two parts of wheat bran and corn silage as freely as the cows would eat it. A calculated ration nearly always is taken as the basis and followed very closely except where a cow's appetite varies considerably. In the spring with soy-bean silage, corn meal became a part of the ration and several cows were fed on different rations to compare with a mixture sold here. In summer, less soiling and more pasturing was practiced than in 1893. Cows are pastured at night and shut in a darkened shed with as much air as it is possible to give them during hot weather. When pasture became short, soiling was resorted to until the silo was again opened. Soiling crops were corn, prickley comfrey, cow-pea, corn and cow-pea vines. Water has been supplied from the tank the same as last year, and there has been running spring water in the pasture.

II. VARIATIONS OF MILK-YIELD CAUSED BY VARIATIONS IN MILKING.

Wishing to show the importance of some of the so-called lesser details in the routine work of the stable, for the sake of illustration, and tc prove the value of a regular order in doing all the stable work, one cow was milked several times in an unusual way and her milk tested for fat.

The cow is said to be a cross-bred Jersey-Guernsey. She is of an extremely nervous disposition, and in nearly two years in our stable does not allow herself to be handled without quite a show of nervous excitement. This cow was always hampered by a strong strap to prevent kicking at milking, until she was shorn of a beautiful pair of horns which she too vigorously used on her fellows. Then she calmed sufficiently to be milked without the use of a strap, if the milker proceeded in the usual way.

For the first trial on the morning of September 19, one teat was milked at a time, beginning at the right front, then right rear, and ending with the left front. The milk from each teat was weighed separately, sampled and tested for fat. At the evening milking, the cow was milked in the usual way, two teats at a time, right front with left rear first, and right rear with left front last. The milk from each teat was received in separate dishes and again weighed and tested. The following day the milking was done as usual and no tests made, but on the second day the testing was reversed. The morning milking was begun with left front and ended with the right front; at evening the left front and right rear teats were milked first and in separate pails, followed by the other two.

Following are the yields in pounds and the per cent. of fat from each teat for the days named:

September 19, 1893.

	Yield lbs.	Per cent. fat.
Morning Milk.		
Milked 1st right front teat	2.05	4.80
" 2d right rear	1.80	4.50
" 3d left rear	2.20	3.40
" 4th left front	1.55	2.60
	7.60	
Total calculated		3.875
Evening Milk (usual method.)		
First { Right front	2.00	5.20
First { Left rear	2.80	5.80
Last { Right rear	1.55	4.60
Last { Left front	2.20	5.20
Calculated on	8.55	nearly 5.30

September 21, 1893.

	Yield lbs.	Per cent. fat.
Morning Milk.		
Milked 1st left front teat	2.05	4.80
" 2d left rear	2.70	4.40
" 3d right rear	1.70	3.50
" 4th right front	1.85	3.20
	8.30	
Calculated at		4.05
All mixed and tested after first samples, about 20 oz. taken		4.30
Evening Milk.		
First { Left front	1.80	5.20
First { Right rear	1.65	5.80
Last { Right front	2.00	5.40
Last { Left rear	2.25	4.60

Comparing the morning milkings each by itself, if no other causes

were taken into account, perhaps one might be justified in the conclusion that the milk from a given teat is richer than from another, but no explanation is offered for what *may* or *may not* be a fact under normal conditions. Comparing now the two morning milkings with each other, it is observed that the decrease in per cent. of fat was reversed when the order of milking was reversed. It is evident then that the difference is due to another cause than difference in the product of different teats. We have ascribed this difference mainly to interference with the regular order of milking and excitement of the nervous system of the cow. It was evident that the cow became more than usually excited on the morning of 19th inst., when the first change was made, and if this is the cause of the decrease of fat in the milk the second time the change was made, the effect was less than at the first change. A possible reason for a small part of the difference lies in the relative thoroughness with which the last milk from each teat was exhausted. A very little closer to complete dryness from any one teat than from another could slightly change the per cent. of fat from the whole quarter. As proof of this the following result is shown of two milkings previously made with the same cow.

On September 12th, 1893, she was milked as usual except that at the beginning of milking a little milk was drawn from all teats and this first milk tested; the milking then proceeded regularly until the stripping was reached and this part reserved until strippings were obtained and sampled when all of the three portions except the samples from first and last parts were mixed and sampled for a representative of the whole.

At the evening milking, the milk was drawn in three parts, ten streams being taken from each teat at first and as near as possible in the milkers judgment an equal amount for strippings was left for the last part. Following are the results.

Morning Milk:		
First of milking	1.75 pounds.	1.20 per cent. fat.
Last of milking	.60 "	8.40 " "
Total except samples of above	----	4.40 " "
The yield was 7.60 pounds.		
Evening Milk:		
First 10 streams from each teat	1.45 pounds.	1.00 per cent. fat.
Second part of milking	5.00 "	5.80 " "
Third part of strippings	.45 "	9.00 " "
	6.90 calculated at	5.00 " "

This cow is perhaps an extreme case but such changes must be no less real if they are not so marked with other cows. Hence, the extreme care and attention to details and quiet orderly habits necessary to have animals thrive and give profitable returns. This explanation is in harmony with the belief of dairymen generally, and shows why those who pay attention to these matters are more likely to be successful than those who are less careful of the small points, who do not secure all the returns from the feed and care bestowed which the animals are capable of producing.

III. A TEST SHOWING THAT COWS ARE AFFECTED BY CHANGES IN STABLE ROUTINE.

Instances of loss due to strange milkers are doubtless numerous, and it may not be needed to convince dairymen of the necessity of deviating from a regular routine with caution, if they would avoid unnecessary losses. On one occasion* the record of a cow which was giving 7⅜ pounds (about .855 gallon of milk daily), showed a yield of but one pound. Inquiry showed that the established routine, which was to give the cows their feed and then to milk, had not been followed. The assistant had come in late, and in order to milk on time, had omitted to feed first. After stripping faithfully he could obtain only one pound of milk. The next milking was larger than usual, but the irregularity showed that a loss was the result. The yield was for five days, 7.25, 7.38, 6.25, 6.63, 7.30 pounds respectively. The one pound milking occurred in the middle day.

Another cow, if milked before being fed, usually became uneasy and might kick very hard. An examination of her milk showed a decrease of fat. Previously this cow's milk had tested 3.60 to 4.40 per cent. fat. On one occasion only 1.60 per cent. of fat was found in her milk when she was milked before being fed the meal ration. This is a serious loss, and one which can be repeated with this cow** at any time if she is not regularly fed. Lack of attention to these small things is costing many a man the better part of the profit of his dairy.

*Nellie, on April 7, 1892.

**Daisy E. The record cited was February 19, 1894.

Tuberculosis

and its Prevention

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

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THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

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RALEIGH, N. C.

PREFACE.

The subject of the accompanying Bulletin, "Tuberculosis and its Prevention," is one of greatest importance to all the people of the State, not only to farmers, but to dwellers in towns. This is a disease that is known to be communicated in many ways that formerly was not thought possible, and its results are almost as destructive as the results of modern warfare. Its insidiousness is such that we barely think of it as contagious, yet no plague that has ever visited our borders has wrought such disastrous results. We have fears for cholera, yellow fever, and small pox, yet all of these combined have hardly found one-tenth of the victims that have died and are dying of tuberculosis or consumption. It is known that this disease is communicated through milk, or other animal products, as well as by other means directly traceable to persons who have the disease. It is very necessary, therefore, that the subject be carefully studied and such preventive measures adopted as experience has proven requisite. Such matters are treated in the accompanying bulletin and should receive careful attention.

As bearing somewhat upon the subject, the following law of our State (chapter 173, Laws of 1889, as amended by chapter 67, Laws of 1891), is inserted. It deals more particularly with hog cholera, but refers (section 2) as well to "*other infectious diseases*:"

SECTION 1. That any person having swine affected with the disease known as hog cholera and discovering the same, or to whom notice of the fact shall be given, shall immediately secure the diseased swine from the approach or contact with other hogs not so affected, by penning or otherwise securing and effectually isolating them, and such swine shall be so penned or confined that they shall not have access to any ditch, canal, branch, creek, river or other water-course which passes beyond the premises of the owner of such swine.

SEC. 2. That when any hog or other animal shall die with the hog cholera or other infectious disease, it shall be the duty of the owner thereof to so bury the same as to secure it from the reach or contact with other hogs or other domestic animals of value, and he shall not throw or place such hog or other animal in any ditch, canal, branch, creek, river or other water-courses passing beyond his own premises.

SEC. 3. That any person violating the provisions of this act, or neglecting for five days after it shall come to his or their notice that the swine are affected, and failing to comply with this act, shall be guilty of a misdemeanor and fined not exceeding five dollars, or imprisoned not more than ten days.

More stringent laws than the above are needed in respect to other infectious and contagious diseases, such as the one particularly described in this Bulletin. The increase of knowledge, caused by the dissemination of this and similar literature, will, doubtless, before long, result in the passage of such laws as the importance of the subject demands.

H. B. BATTLE, *Director.*

TUBERCULOSIS AND ITS PREVENTION.

BY F. P. WILLIAMSON, CONSULTING VETERINARIAN, AND F. E. EMERY, AGRICULTURIST.

INTRODUCTORY.

The diseases of domestic animals, and especially those of the bovine family with which human life is so intimately associated, becomes of interest to every thoughtful person. When it is considered that nearly all people are partially fed at some portion of, or all of their lives, from the milk or meat products of cattle, and that diseases may be transmitted through this food to them, it is evident that it is of the greatest importance that every family should investigate the health of the animals, the products from which they are to use for food.

By ordinary examination it is impossible to know that the milk, butter and cheese on the table come from healthy cows, or that the beef that one buys is a part of a sound, healthy bullock, or that pork, fowls and other meats are fit for food. Co-operation, however, could secure an assurance of these conditions by obtaining local laws in regard to inspection of stock and slaughter houses.

In an address upon this subject before the Alumni of the University of Buffalo, Dr. James Law commented on the great sanitary importance of the Mosaic Law, and pointed to its good fruits in the comparative immunity of the Israelites from such diseases as trichinosis, the pork tape-worm, and tuberculosis. But he further pointed out that "whole genera of wholesome animals are prohibited to avoid the danger of a few of each genus conveying deadly poisons; and the wholesome flesh of the imperfect or injured animal is condemned equally with that which is the subject of a fatal infection. Moreover, some of the most deadly diseases (like anthrax) affecting the blood and spleen only, may still pass as wholesome, because no solid tissue of the body has been observed to be diseased." "With our modern knowledge of the life-history of parasites and the microbes of disease this crude and unintelligent selection and rejection must give place to a true scientific scrutiny; and every available resort, microscopic and otherwise, must be brought into requisition to protect the public from the truly dangerous animal foods. To illustrate the field that must be covered, I shall name a few of the diseases of our meat-producing animals that are communicable to man." Ten diseases were named and commented on at more or less length. These were: Tuberculosis, anthrax, black quarter, diphtheria, glanders, canine madness, tetanus or lock-jaw, milk sickness, foot and mouth

disease, *actinomycosis*, the lump-jaw of cattle, after which reference was made to the great desirability of public abattoirs owned and controlled by cities and towns, containing booths to be rented by butchers, and all under the inspection of a well-trained sanitary officer. The community has a right to protect its health by the control of slaughter houses and the rigid scrutiny of all sources of its meat supplies, but if in so doing it imposes any undue burden on the honorable butcher, it will only serve to arouse opposition and defeat its own end.

In the line of dairy products, too, there should be no less vigilance than is allowable for the meat supply. There is every reason to believe that many infectious and contagious diseases are spread by the milk and other dairy products from infected herds, or from diseased persons handling the herds and products. Some notes of work on this phase of the subject, undertaken several years ago in Massachusetts and carried out by Dr. Harold C. Ernst, of the Harvard Medical School, have been summarized in a recent Bulletin of the State Board of Health.* It shows that there is a positive danger in transmitting tuberculosis through milk of cows affected by the disease.

This is doubtless new to many of our people, but the facts are so startling when one considers the inroads of tuberculosis, that every possible means should be adopted to spread information concerning it, and thus enable every one to realize the danger and help to reduce the mortality from its ravages. North Carolina is rightly considered a healthy State. It is becoming to be a Mecca for consumptives, yet it is estimated that the dread disease destroys four thousand of our people annually.† To help isolate and destroy some of the sources of this disease, is the object of the present bulletin.

This Station has tested its herd for tuberculosis, by the use of tuberculin, soon to be described, and one animal was found to be affected. This one was not in an advanced stage of the disease, and could not, so far as known, have been a source of infection. It was destroyed and the carcass buried, after careful *post mortem* examination, which, however, failed to reveal the characteristic bacillus. Judging by the opinion of some, a very large fine beef animal was sacrificed needlessly, but according to Dr. Law and a constantly growing sentiment, it was the proper course to pursue, as we cannot know how many lives might have been shortened by consuming such beef, when already charged with the quickening poison from the growth of the bacillus tuberculosis in its tissues. This animal was buried with a free use of lime, instead of burning, as more advanced cases should be treated.

The following brief account of the disease, tuberculosis, has been prepared for those who are not otherwise provided with literature on the subject. It is to be hoped that every one who takes an inter-

*Bulletin N. C. State Board of Health, April, 1895. Supplied upon application to Dr. R. H. Lewis, Secretary, Raleigh, N. C.

†Dr. S. Westray Battle in Fifth Biennial Report N. C. State Board of Health, page 173.

est in matters of such importance, will secure the literature of the North Carolina State Board of Health and make this reading but the first step toward their efforts to aid in arresting this dread disease. This Station will aid any citizen in examination of suspect ed stock, whenever possible, and give such other assistance as lies in its power. It is desirable that all suspected stock should be examined and cleared of suspicion, or isolated and destroyed, according as they may be harmless or dangerous to the health of human beings. One case of co-operation between this Station and Dr. Hill (described later in this Bulletin), has resulted in clearing the cows of suspicion.

Tuberculosis.

This disease is exciting more interest at the present time than any other, and with good reason. That it is due to the action of the bacilli tuberculosis and the toxines they produce, is accepted generally, since the separation and cultivation of the same, as reported first before the Physiological Society of Berlin, March 24th, 1892, by Dr. Robert Koch.

Villemin was the first systematic experimenter in artificial tuberculosis, that is, where the healthy animal is inoculated directly. He used tuberculous lung tissue from human beings and cattle (affected with pearl disease), and proved the identity of the two.

For a long time the idea of tuberculosis being due to a germ, was disputed on account of want of proof, the opposition claiming that the inflammation accompanying the subcutaneous injection of any material from a dead body, would produce the disease, whether or not the subject had died from tuberculosis. After it was admitted that the bacilli was always present in whatever place the disease was found, then it was contended that the presence of this micro-organism was an accidental accompaniment, a matter of chance, not a cause. If the dead tissue or the coagulated blood that is injected along with the germ causes the disease, and not the germs themselves, then where the germs were separated from dead tissue, coagulated blood and detritus, and the germs themselves injected, the disease ought not to be produced. The micro-organisms on the contrary, when injected after being separated, will produce the disease.

The separation of the bacilli from the subject is done by a process of cultivation. Matter containing bacilli is placed on beef tea, treated with glycerine or some other suitable substance, and kept at body temperature. After two or three weeks they show some growth, or spread out, and from this enlarged grey mass, no longer red from blood, a small portion is transplanted to another place. They can be planted in lines or figures as desired, just as clover seed on a lawn. This transplanting is done for twenty, fifty, or as many times as desirable. Not the slightest trace of blood can be found, even after the first few cultivations.

Dr. Koch gives numerous examples of culture, carried on for different lengths of time:

1. Human lung-phthisis cultivated through twenty-two months, therefore almost two years, in thirty-four successive breedings;

4. Human miliary tuberculosis (tubercle of the lung) cultivated for seven months in twelve successive breedings;

7. Human tuberculosis of the uterus, cultivated for four months in six successive breedings;

10. Scrofula in man (excised neck-gland), cultivated for seven months in twelve successive breedings;

11. Tuberculosis in monkey (lung-tubercle), cultivated for six and one-half months in twelve successive breedings;

14. Tuberculosis of cattle (pleura knots), cultivated for three months in five successive breedings;

15. Tuberculosis of cattle (pleura knots), cultivated for three and one-half months in five successive breedings;

19. Tuberculosis of cattle (pap-like caseous masses from the lung, first case), cultivated for eight months in thirteen successive breedings;

29. Scrofulous gland, cultivated for six months in seven successive breedings;

34. Fungous joint, cultivated for fifteen months in nineteen successive breedings;

35. Lupus, cultivated for sixteen months in twenty-one successive breedings;

40. Caseous pneumonia of the pig, cultivated for five months in eight successive breedings;

41. Spontaneous tuberculosis of guinea pig (knots from the lungs), cultivated for six months in nine successive breedings.

As would be expected, animals injected with tubercle bacilli dying from the disease, would be found to contain the bacilli in greatly increased number. First attempts to discover these micro-organisms with a microscope were unavailing, on account of their small size. Already some work had been done in the study of germ diseases by means of certain different coloring agents, which would color the surrounding matter one color, leaving the germs in relief. Following the methods of coloring other bacilli, a concentrated solution of vecuvian was used. This colored the surrounding substance brown, leaving the bacilli blue. Other methods of coloring used are those originated by Ehrlichs and by Weigerts.

The bacilli of tuberculosis are very minute, rod-shaped plants, varying in size from 1.6400 to 1.12800 of an inch. They are either arranged in groups or found alone. Sometimes they are in chains, sometimes they are bent or crooked. They are found in greater abundance where the lesions are acute, as in acute phthisis, being less abundant in chronic cases of lupus. In nature they do not increase except in animals that are warm-blooded. They multiply bv spore formation. Twenty minutes in boiling water destroys their

life. In the dried state they remain inactive for a long time. But this does not affect their virulence if favorable conditions are again offered. In cold they remain inactive.

Milk and meat of animals suffering from the disease, are, without doubt, often means of communication of the bacilli to human beings. For few, if any, of the warm-blooded animals escape; according to Koch, there is not one that is not responsive to infection. But the dried sputum of consumptives, which floats in the air on particles of dust, is the most common way of spreading disease. Tuberculosis in the human subject has probably received most attention in the form of phthisis pulmonalis (consumption). The hurried breathing, cough, rapid pulse, chest pains, rapid loss of flesh and strength, fevers at intervals, the hectic flush, finally the occasional hemorrhages becoming gradually more and more frequent, are the signs familiar almost to every one.

Twenty-one cases of so-called scrofulous glands and seven cases of lupus were examined by Dr. Koch, microscopically, and found to contain the bacilli of tuberculosis, which produced the disease on injecting guinea pigs. This foretells the day when scrofula and lupus will become obsolete terms.

As might be expected, the tuberculosis of animals from a clinical standpoint, differs somewhat from the tuberculosis of human beings, although histologically the changes are strikingly similar. The disease in cattle follows more nearly than in any other animal, the course it does in our own species. Narrow-chested, highly-bred cows are most frequent sufferers. The cough is present, the visible mucous membranes lose their rosy color, the febrile symptoms are not wanting, the staring dry coat, the breathing is more or less rapid, pulse quick, patient weak, milk lessened in quantity, bluish and easily souring, appetite irregular, pain on pressure of side. Cows, from their place of usefulness in furnishing milk and butter, are always under a constant strain of constitution; also as they are often in crowded, badly ventilated stables, they are fit subjects for the affection. For not alone is it necessary for the bacilli to be present, but the soil must be suitable for growth and development. The beautiful but delicate highly inbred Jerseys that are kept closely confined and strained to their limit for large yields of milk and butter, are typical subjects for tuberculosis, along with other highly bred ones, such as Guernseys, Holsteins, etc. Among such cows there have been many cases, as proven in New York and other States, where the Boards of Health have been studying the subject. The native animals and grade cows, on the contrary, are almost entirely free.

In regard to the number of animals found infected, a portion of a letter concerning the old method of diagnosing this disease, written by Dr. E. Salmon, Chief of the Bureau of Animal Industry, U. S. Department of Agriculture, and published in the *Veterinary Review*, is here inserted: "Recent investigations have shown that observations made in this way are very unreliable, and that the percentage

of affected animals so discovered must be entirely too low. Within the last two or three years tuberculin has been extensively used to determine the existence of tuberculosis in animals, and the results which have been reached with it, show that a large proportion of the tuberculous animals have been overlooked, both in the examination before death and in the ordinary *post mortem* examinations. Tuberculin has been used to a considerable extent in diagnosing this disease in Europe, and, instead of there being from five to fifteen per cent. of the dairy cows affected, as appeared from older statistics, scientists are now beginning to talk about from forty to seventy-five per cent. of the cows showing the presence of the disease. Tuberculin has not very largely been used in the United States, and in most cases where it has been, the herds were known to be tuberculous. For this reason the results of its use in this country do not furnish a reliable indication of the percentage of animals affected. In the individual herds which have been tested with tuberculin, from fifty to seventy-five per cent. of animals have been affected. In Europe, as many as two hundred and fifty animals have been tested by the same observer, and have shown from sixty to seventy-five per cent. tuberculous. This indicates that a much larger proportion of dairy cows are affected than has been supposed. We should say, in explanation, that many of the animals which were shown to be tuberculous by the use of tuberculin, are only very slightly affected, and it requires the most careful scientific examination of the carcass in a considerable proportion of the cases to discover the tuberculous centers. Sometimes only one of the small lymphatic glands is affected, and a microscopic examination may be necessary to discover the effects of the disease."

The State Agricultural College of Maine destroyed an entire herd of fifty-seven animals. Prof. Julius Nelson, of the New Jersey Agricultural Station, found seventy per cent. of their Station herd tuberculous. Austin Peters, M. R. C. V. S., in the winter of 1892, examined a herd in West Chester County, New York, and found eighty-four per cent. tuberculous. Mr. F. W. Hawley, of Pittsford, New York, turned over "his entire herd of pedigreed animals (160)," to the State Board of Health to be destroyed, because tuberculous (reported by L. McLean, M. R. C. V. S) Hon. Levi P. Morton had twenty out of a herd of sixty-two Guernseys destroyed, according to tests by Dr. J. Faust, Poughkeepsie, New York. Dr. Charles E. Clayton reports seventy per cent. destroyed of a herd near New York City. Many more cases might be cited, but these are sufficient to show how prevalent this disease is near our large cities In regard to domestic pets, Dr. Richard Middleton, of the Berlin Hospital for Small Domestic Animals, reports twenty-seven cases of phthisis out of six hundred and twenty-five thousand sick dogs, or .04 per cent. Six cats out of six hundred and fifteen, and of seven hundred parrots, twenty-five per cent.

There are many cases where the symptoms are so obscure that a

satisfactory diagnosis is impossible, owing to so great thickness of fat, or from the fact of any disarrangement of the normal conditions being too minute to discover with the senses. In these cases it is customary to inject some modification of Koch's Lymph (Tuberculin) or to innoculate some of the lower animals (guinea pigs, rabbits, rats, etc.), with some of the secretions from suspected subjects. At times both tests are used to verify the diagnosis. In the herds cited, tuberculin was used more or less in each case. Tuberculin is an extract from some tuberculous matter that is thoroughly sterilized. This is injected under the skin with the result that there will be a certain rise in the animal temperature if tuberculous, if not tuberculous, there will be no variation of temperature. However, practically, it has been found that the temperature may rise in pneumonia, bronchitis, and certain other diseases. Taken in conjunction with physical examination and not used blindly, tuberculin is a most valuable agent, as proven by experiments of many scientific men of this country and Europe.

Dr. James Law has recently called attention to "tubercular poisoning" in distinction to "tubercular infection," in which he points out the fact that meat, milk, butter, or cheese from infected animals, even if cooked, *i. e.*, sterilized, still are not relieved of their toxines, therefore act as tuberculin, causing a rise in temperature, and if in sufficient quantities,. the toxines may change a chronic into an acute case of tuberculosis.

J. Faust, V. S., Inspector of New York State, used a preparation of the following: Koch's Tuberculinum 2½ drachms—one bottle, in 18½ drachms one per cent. solution of carbolic acid and distilled water, making twenty drachms of solution. He used from twenty to sixty minims in experiments.

Tuberculin Tests at this Station.

In the tests employed at this Station, the tuberculin used was kindly supplied by Dr. D. E. Salmon, Chief of the Bureau of Animal Industry U. S. Department of Agriculture. Each adult received 2 cc. (about 30 minims). The smaller, young animals, Polly B. and Trixy's Rioter, each received 1½ cc. Four steers received each 3 cc. Seneca, the large bull, weighing about 1900 pounds, received a double dose of 4 cc. The animals tested with tuberculin were treated as usual. Feed and water were given at the usual times and nothing unusual was apparent, except the presence of the operators in taking temperatures. This process greatly excited one cow, "Spot." The slightly higher temperature at 6 and 8 A. M., March 20th, may have been due to this excitement. On this day cow No. 5 was served by Seneca between the hours of 8 and 9 A. M.

February 20th, 1894, temperatures were taken from 6 A. M. to 12 P. M., at intervals of two hours (Table No. 1). At 12 P. M. injections were made on under side of neck. Commenced taking temperatures

TABLE I.—Preliminary Work in observing Temperatures of Animals previous to injecting Tuberculin. Test at Experiment Farm, February, 1894.

TIME, Feb. 20th, 1894.	Seneca.	No. 2.	No. 5.†	No. 7.	Guernsey J.	M. Haley.	Spot.	No. 14.	Daisy E.	Dora McKee.	Trixy's Rioter.	Polly B.	Steer No. 1.	Steer No. 2.	Steer No. 3.	Steer No. 4.	M. Edwards.
6—7 A. M.	101 6	102.0	102.2	101.8	102.0	102.0	102.2	102.0	102.3	101.8	102.0	102.6	101.8	103.6	102.6	102.6	101.6
8—9 A. M.	101 4	101.6	102 0	101.8	102.8	102.2	102.2	101.8	101.2	101.6	101.6	102.4	101.6	102.0	102.6	102.4	101.4
10 A. M.	101.8	101.4	102.2	101.6	101.8	101.8	101.8	101.8	101.6	101.2	101.0	102.0	101.8	102.2	102.4	102.2	101.0
12 M.	101.7	101.7	102.0	101.6	101.8	101.4	101.6	101.8	102.2	102 0	102.0	101.8	102.2	102 6	102.4	102.2	101.8
2 P. M.	101.9	101.8	102.0	101.6	101.8	101.6	101.8	101.8	101.2	101.0	101.8	101.8	103 0	102.8	102.4	102.3	101.6
4 P. M.	101.9	101.2	101.9	101.6	101.8	101.6	101.6	102.0	102.0	101 4	101.2	102.0	103.2	103.2	102.4	103.2	101.8
6 P. M.	101.4	101 8	101.8	102.2	102.2	101.9	101.8	101.8	101.8	101.9	101.6	101.8	102.2	102.0	102.9	102.0	101.8
8 P. M.	101.4	101.8	101.8	101.8	101.9	101.6	101.8	101.8	101.8	101.6	101.6	101.9	102.0	102.4	102.2	101.9	101.9
10 P. M.	102.2	101.4	101.9	102.2	102 0	101.4	101.8	101.8	101.2	101.2	101.2	101.5	102.3	102.2	102.0	102.2	101.2
12 P. M. Injected Tuberculin from Bureau of Animal Industry as follows, in cubic centimeters.	4 cc.	2 cc.	2 cc.	2 cc.	2 cc.	2 cc.	2 cc.	2 cc.	2 cc.	2 cc.	1.5 cc.	1.5 cc.	3 cc.	3 cc.	3 cc.	3 cc.	2 cc.
Mean temperature previous to injection.*	101.7	101.6	102.0	101.8	102.0	101.7	101.8	101.8	101.7	101.5	101.6	102.0	102.2	102.5	102.4	102.3	101.5
Weight of Animal Feb. 1st, in Lbs.	1876.	907.	912.	996.	899.	798.	838.	899.	858.	903.	617.	481.	1015.	918.	969.	856.	

*Cows watered 8 to 9 A. M., and 3 to 4 P. M. Temperature of water 45°F.
†Cow No. 5 in œstrum and served by Seneca above after his 8 and before 10 o'clock temperature was taken

again at 6 A. M., February 21st, and continued until 12 P. M. (Table No. II). As Seneca was from a herd that proved tuberculous after he left it, and as also his reaction warranted, he was treated a second time with tuberculin, with some others, as shown by Table III. Dr. Salmon, in response to the enquiry, writes in regard to the second test as follows: " When an animal has once been tested with tuberculin, even though affected with the disease, it does not always give as great a reaction the second time as the first, and as a rule the increase in temperature is lessened with each additional test that is made. Consequently the first test is the only one that is thoroughly reliable with animals giving a reaction."

According to suggestion, only 3 cc. of tuberculin was used on Seneca at this time, as he was only three years old in January. His temperature still rising to 105.2 at 12 M., March 22d, it was decided to destroy him, as this fact, together with his history, made it unwise to keep him for public service or to let him stay with the herd. A most careful examination at the *post mortem* revealed nothing suspicious, nor did the specimen sent to the laboratory at Washington for microscopic examination contain a single bacillus tuberculosis that could be found.

" Cow No. 14 " died April 3d from shock brought about by *partus præmaturis*. *Post mortem* showed lungs to be in a high state of hyperæmia, right lung at apex exhibited numbers of little nodules on manipulation. On cutting there exuded from these nodules a thin, yellowish, pus-like fluid. These nodules were thought to contain the bacilli of tuberculosis, but failed to answer to staining upon microscopic examination. In the larger bronchi were found the black hulls of cotton seed. These hulls in smaller pieces followed the smaller bronchial tubes to their smallest ramification. This cow was purchased in June, 1893. She appeared all right, ate heartily and gave a fair amount of milk. She was treated as all other cows in the herd and fed the same. She was very quiet and gentle, so much so as to cause remark. After a little time there was noticed a rather livid, bloodless condition of the skin at exposed places as at the vulva. This led to some handling, and a slight thickening of the skin of the dew-lap was found. This may have been done by contact with the stanchion in the stable. Then her quietness, which was noticeable, increased the suspicion that all was not right with her, although keeping in good flesh, something hidden seemed to be destroying her vital energy. All that had been noticed was an occasional cough when in the yard with other cows, which might have been chargeable to a drink of water rapidly taken; or perhaps a little water drawn into the trachea, if hastily driven from the trough. The first faint suspicion of disease grew, however, until this cow was isolated, after having shown a slight rise of temperature with the tuberculin test and a preliminary physical examination had shown some lung trouble. This cow died from shock of abortion as before noted. She was undoubtedly kept in a low, weak

TABLE II.—Temperature of Animals following Injection of Tuberculin, February 20th, 1894.

TIME, February 21st, 1894.	Seneca.	No. 2.	No. 5.	No. 7.	Guernsey J.	M. Haley	Spot.	No. 14.	Daisy E	Dora McKee.	Trixy's Rioter.	Polly B.	Steer No. 1.	Steer No. 2.	Steer No. 3.	Steer No. 4.	M. Edwards.
Mean temperature previous to injection.*	101.7	101.6	102.0	101.8	102.0	101.7	101.8	101.8	101.7	101.5	101.6	102.0	102.2	102.5	102.4	102.3	101.5
6 A. M.	101.2	101.9	101.6	101.6	101.8	101.4	101.8	101.8	102.0	101.2	101.8	102.2	101.8	102.0	102.0	101.8	102.2
8 A. M.	101.2	101.4	102.0	101.4	101.6	101.6	101.4	101.4	101.4	101.6	101.4	102.2	101.9	102.2	102.3	101.8	101.8
10 A. M.	101.8	101.4	101.3	101.9	101.9	101.4	101.8	101.9	101.3	101.4	101.6	102.0	101.8	102.2	102.1	101.4	102.0
12 M.	103.8	101.4	102.4	101.6	102.4	101.8	102.0	101.8	102.9	101.4	102.0	102.2	102.2	102.2	102.4	102.0	102.2
2 P. M.	106.4	101.4	101.2	101.6	101.6	101.0	101.4	101.8	101.4	101.9	101.2	103.0	102.6	102.8	102.0	102.0	102.0
4 P. M.	107.2	101.4	101.4	101.6	101.8	101.6	101.4	102.0	102.2	101.9	102.2	102.2	103.0	102.6	102.9	101.9	102.2
5 P. M.	107.0																
6 P. M.	105.6	101.2	101.4	102.0	102.2	101.4	101.8	103.0	102.0	101.9	102.0	103.0	102.6	102.2	101.9	102.2	102.2
7 P. M.	105.8																
8 P. M.	106.4	101.9	101.6	101.8	102.6	101.3	101.6	103.4	101.9	101.6	102.0	102.9	103.0	103.0	102.2	102.4	101.9
9 P. M.	106.0																
10 P. M.	105.4	101.8	101.6	101.7	102.2	102.0	101.6	103.0	101.9	101.4	101.6	103.0	102.0	103.2	102.0	102.2	101.6
11 P. M.	105.4																
12 P. M.	105.4	101.6	102.0	102.0	102.0	102.0	101.8	101.1	101.4	101.4	101.8	102.4	102.0	103.0	102.0	102.2	101.4
1 A. M.	105.5																

*See Table I.

the time of the last calving or since, the condition of her lungs and the presence of so much foreign matter (cotton-seed hulls) could be accounted for. The cow had been in milk from four to six or eight weeks when she came to the Experiment Farm. The hulls were probably the prime cause of her quietness and reduced her so much that abortion overcame her.

"Miss Edwards," who was suffering from actinomycosis, had no material rise of temperature, as shown by the table February 20th, 8 P. M., highest normal temperature 101.9 against 102.2 after injection February 21st at six different readings, which was a rise of but 0.3 of a degree. A rise after injection was only 0.6 of a degree March

TABLE III.—Record of Temperature after second Injection of Tuberculin at 10 P. M., March 21st, 1894.

TIME.	Polly B.	No. 14.	Seneca.	Steer No. 1.	Steer No. 2.	Mr. Edwards' Cow.
	MARCH 21, 1894.					
Before Injected.						
5 P. M.	102.6	103.2	103 4	103.2	103.8	102.0
10 P. M.	102.4	103.0	102.0	102.8	103.2	102.0
	MARCH 22, 1894.					
After Injected.						
6 A. M.	102.0	102.8	102 0	102 2	102.8	101.8
8 A. M.	102.0	102.4	103.0	102.0	102.8	101.0
10 A. M.	102.0	102.2	104.2	101.8	103.4	101.6
12 M.	103.4	102.2	105.2	102.4	103 8	101.8
2 P. M.	100.8	103.4	104.8	102.5	103.0	101.4
4 P. M.	102.6	103.0	104.6	103.0	103.6	102.0
6 P. M.	102.8	102.5	105.0	102.4	103.0	102.6
7.25 P. M.	102.6	....	....	....	....	102.6

NOTE.—All were fed at noon, and Seneca, Polly B. and Mr. Edward's cow were watered. No note was made of the water drank, but it must have been considerable by both Seneca and Polly B. Polly's temperature was taken a second time at 2 P. M. to verify the record. Seneca weighed 2010 lbs. at night against 1922 lbs. on previous night when not watered at noon. F. E. E.

condition by the presence of the large mass of foreign matter in her lungs having hindered the proper aeration of the blood, and consequently her life current was not as strong as it should have been. How the cotton-seed hulls were conveyed to the lungs is a matter of conjecture. A possible explanation may be offered from the similarity in the case of one of the two steers, the lungs of which were examined when the steers were slaughtered. Both steer's lungs were healthy and one was free from any foreign matter. The other steer, by an accident, was not so quickly killed as the first; struggled some and vomited when down, and some of the stomach contents of cotton-seed hulls and meal were drawn into the lungs and found far out in the bronchial tubes. Had cow No. 14 been sick sometime previous to our purchase, or had she thus drawn stomach contents into her lungs at

22d. Of course, no conclusion could be drawn from the action of tuberculin on actinomycosis in one single case. It is only reported as it happened. Steers Nos. 1 and 2 were butchered for beef, the lungs were saved and examined, but proved to be normal.

"Polly B." still remains in the herd, and to all appearances is in the same degree of health as when tested. She is still giving milk and is proving more than an ordinary individual.

Test with Tuberculin by Dr. Joel Hill, Arcadia, N. C.

Dr. Joel Hill, Arcadia, N. C., wished to observe the tuberculin test on two cows at his place, and the lymph was sent him from that received from Washington, D. C., in sufficient quantity to make the tests. The animals examined were "Red," a grade-Jersey cow, aged nine years. The injection was 30 minims at 9 P. M. April 4, 1894. The second cow was "Fan," a grade Holstein four years old, the time and amount of injection was the same as for Red. The condition of both cows was good, and there was no indication of disease.

Dr. Hill reports as follows, saying he is satisfied that the animals are in a healthy condition:

TABLE IV.—Record of Temperatures before and after Injection of Tuberculin in two cows by Dr. Joel Hill, Arcadia, N. C.

Time.	Grade Jersey Cow, 9 years old.		Grade Holstein Cow, 4 years old.	
April 4, 1894.	Before Injection.	After Injection.	Before Injection.	After Injection.
9 A. M	99.4		100.4	
11 A. M	98.6		99.2	
1 P. M	98.6		100.2	
3 P. M	98.6		100.6	
5 P. M	101.		100.8	
April 5, 1894.				
7 A. M		99.2		99.4
9 A. M		98.6		99.6
11 A. M		99.4		99.8
1 P. M		100.4		99.8
4 P. M		100.8		100.8

Prevention of Tuberculosis.

As regards preventive measures concerning tuberculosis, the Board of Health in different portions of the world recognize the importance of the subject as the following will illustrate:

The Paris Congress on Tuberculosis, adopted the following in July of 1893:

1. That butchers' meat should not be offered for sale until it has

been passed as healthy by a competent inspector, and that the inspection of meat should be made in villages as well as in towns.

2. That public schools should be provided with spittoons in sufficient number, so as to prevent children from spitting on the floors, and that instructions be addressed in this sense to the managers.

3. That there is reason to demand that every animal about to be exhibited at a show subventioned by the State shall have been previously submitted to the tuberculin test.

4. That the tutors and inspectors of the Academy follow the example of those of Bordeaux and Chermont, and invite the institutors to join in popularizing prescriptions against the contagion of tuberculosis.

5. That dead bodies should undergo an absolute disinfection before burial.

6. That tuberculous persons should be collected in special hospitals in groups, according to the stage of the disease, and all the fewer as the malady is more advanced; while as a transitory measure, the duration of which should be as brief as possible, the phthisical should be gathered in special halls, which ought to be disinfected by the procedures now in vogue.

7. That apparatus for the sterilization of flesh from the tuberculous animal be installed in abbattoirs in order to allow of the utilization of such flesh without any danger.

According to Dr. J. M. Parker, Michigan was the first State whose Board of Health took any action in regard to this matter, deciding that "Consumption is a dangerous, communicable disease and must be reported to physicians and householders and to the several Boards of Health." This was on September 30th, 1893. In October of the same year, the Board of Health of Philadelphia considered somewhat similar action.

The American Public Health Association met with the International Congress of Public Health and adopted the following resolutions for prevention of the disease:

1. The notification and registration by health authorities of all cases of tuberculosis which have arrived at the infectious stage.

2. The thorough disinfection of all houses in which tuberculosis has occurred, and the recording of such action in an open record.

3. The establishment of special hospitals for the prevention of tuberculosis.

4. The organization of societies for prevention of tuberculosis.

5. Government inspection of dairies and slaughter-houses, and the extermination of tuberculosis among dairy cattle.

6. Appropriate legislation against spitting into places where the sputum is liable to infect others, and against the sale or donation of objects which have been in use by consumptives, unless they have been thoroughly disinfected.

7. Compulsory disinfection of hotel rooms, sleeping-car berths, and steamer cabins which have been occupied by consumptives, before other persons are allowed to occupy them.

Dr. James Law, Cornell University, says: "If he will, the stock-owner can extirpate this disease from his herd and thereafter keep the herd pure from contamination. The following are the main precautions necessary to this end:

"1st. Board up the partitions of the stalls at the front so that no two cows can feed from the same manger, nor lick each other.

"2d. Keep each animal strictly by its own stall or manger.

"3d. When an animal is suspected, don't let it use a drinking trough nor bucket in common with other animals.

"4th. Avoid all milch cows and unthrifty ones, or keep them secluded from the herd."

" Dr. F. L. Russell, Orono, Me., concludes with this: 'After a herd is once free from tuberculosis, we can only be sure of keeping it free by attention to the following details:

"1st. Have the barn thoroughly disinfected.

"2d. Re-test the herd at intervals.

"3d. Test all purchased animals before adding them to the herd.'"

Some mooted points which have been clearly proven, are:

1st. That tuberculosis or consumption is acquired after birth and no more than a weakness, or tendency to take it, is inherited.

2d. That it may be acquired by anyone who is in a receptive condition when and where the living bacilli are numerous.

3d. That every consumptive gives off millions of bacilli in sputum and body dejections, which when left where they may become dry, can form part of the dust of the streets, or infect walls and floors and flourish in whomsoever is unlucky enough to inhale them and who has any raw mucus surface in which they may lodge

4th. That the milk from tuberculous cows may impart the disease, although their udders are perfectly free from the disease.

5th. That "Sterilizing" milk may destroy the bacilli, if any are present, while the poison from them would be likely to hasten a latent into an active case, and shorten the days of a consumptive partaking of it.

6th. Native and grade cows are less likely to have tuberculosis than stock which has had better care and been confined to barns more than have the less profitable common animals.

7th. That fowls and swine may acquire and communicate the disease very readily if given access to the dejections of human consumptive patients.

8th. That sheep are seldom affected, hence mutton is least likely to convey tuberculosis of all meats of domestic animals.

9th. Cats and dogs, rats and mice, are all sources of infection.

10th. If a general movement can be inaugurated to find and repress the sources of infection, it will surely save many of the victims that are now annually lost to their families, their friends and their State.

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No. 117. Tuberculosis and its Prevention, pp. 20.

Cotton-seed Hulls and Meal for Beef Production

INCLUDING

A DISCUSSION OF THE DIGESTIBILITY OF THE RATIONS.
THE EFFECT OF MEAL ON THE DIGESTIBILITY OF HULLS.
THE FERTILIZING CONSTITUENTS OF THE RATIONS RECOVERED IN THE MANURE.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

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THE NORTH CAROLINA

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INCLUDING

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AND THE STATE WEATHER SERVICE,

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COTTON-SEED HULLS AND MEAL FOR BEEF PRODUCTION

INCLUDING

A DISCUSSION OF THE DIGESTIBILITY OF THE RATIONS.
THE EFFECT OF MEAL ON THE DIGESTIBILITY OF HULLS.
THE FERTILIZING CONSTITUENTS OF THE RATIONS RECOVERED IN THE MANURE.

BY F. E. EMERY, AGRICULTURIST, AND B. W. KILGORE, ASSISTANT CHEMIST.

The subject of feeding cotton-seed hulls for the production of beef has been studied before by this Station and from different standpoints. "Will it pay?" is one of the standard questions. "When will it pay?" is another and "How should the animal be fed to pay?" is still another of the questions often asked. Partly to answer these, for the benefit of the feeders of the State, experiments were begun here as early as October, 1889. Trial after trial has been made and farmers and business men have followed these experiments, as well as conducted some of their own, and many have been led to believe that "it does pay," if not in net cash, at least in the value of the manure which the steers leave behind after the fattening has been completed.

Hand in hand with the feeding experiments, digestion experiments have been conducted since the first year. The digestibility of the rations fed have been determined for cotton-seed hulls alone, and fed with meal at the rate of 7 of hulls to 1 of meal, down in constantly narrowing ratios of hulls to meal, until the rations fed in the trials reported in the present bulletin have reached the narrow proportions of 2 pounds of hulls to 1 of meal and 1½ of hulls to 1 of meal. The first ration of hulls alone was not a maintenance ration. The next was a little more than a maintenance ration, in which hulls and meal were fed and eaten in the ratio of 7 to 1, respectively. The changes of rations have brought changes in results from slow to faster fattening. The digestion work has afforded the key to the reason for these changes, and has given us some valuable additions to the previous knowledge of the subject. The present experiments have been designed as the closing ones of these dual series. The highest, or heaviest, feeding of cotton-seed meal yet attempted for any considerable time, so far as we are aware, has been done in these experiments, and successfully too. The results in some respects

surpass most sanguine expectations. That steers could be induced to eat day after day for weeks and months nearly one pound of dry cotton-seed meal for each 100 pounds of live weight, with no perceptible break in health or appetite, would hardly have been expected. Yet this was done. The feeding during the whole time was on the ratios named, or very near those ratios, and for some time before each of the digestion periods there was no waste, *i. e.*—the steers ate all the food offered them. More was not offered after these rations were determined, because each had been gauged as near his capacity as it seemed possible to reach.

The Steers and the Rations Fed to Them.

Steer No. 1 was a mature ox, which had been worked. He was of a decidedly beef form and was quiet and docile in confinement. Steer No. 2 was also a mature ox, that doubtless had done much hard work. The narrow sloping shoulders, high spine, narrow hips, and sharp angular appearance indicated other than the kindly feeder, yet this steer ate his rations well and made a very creditable gain in weight. Nos. 3 and 4 were young, 2½ to 3½ years old. They were from southwestern Virginia, showed no appearance of having been worked, and were apparently grade shorthorns, though of rather a long-legged type. No. 3, was evidently older than No. 4, and weighed, at the beginning of this experiment, 135 pounds more than did No. 4.

All four steers were being fed a fattening ration of cotton-seed hulls and meal when purchased and were considered fat steers for the Raleigh market. They were, therefore, put at once on heavy rations of cotton-seed hulls and meal, such as is purchased in bulk at the Raleigh Oil Mills. Presumably, they are the same at every other mill, excepting some slight differences in the cleanness of the operation of freeing the kernels or "meats" of the cotton seed from the hulls, on the one hand, and the finer hulls from the kernels, on the other. These materials were intended to be fed to steers Nos. 1 and 2 in the proportion of two pounds of hulls to one of meal, and in quantity sufficient to be considered all they would eat, yet not enough to cloy the appetite. As fed, these steers received rather too much, at first, after which the amount of food per day was reduced; then again slightly advanced. Steer No. 3 was fed in nearly the same way, except in different proportions, while No. 4, was started on a little less than his appetite demanded, and a slight advance in food was the only change needed. These two steers, Nos. 3 and 4 were fed a ration consisting of cotton-seed hulls and meal in the proportion of 1½ to 1. The feeding began Jan. 9, 1894, and continued to April 15, for Nos. 1 and 2, 96 2-3 days; and to May 24th, for Nos. 3 and 4, 135 days.

The Result of the Feeding.

The steers were fed and ate in pounds as follows:

		Steer No. 1.	*Steer No. 2.*	*Steer No. 3.*	*Steer No. 4.*
Cotton-seed hulls fed		1775.	1569.	2018.	1905.5
Cotton-seed meal fed		899.8	787.5	1350.25	1272.3
Cotton-seed hulls eaten		1661 3	1508.8	1872.4	1771.
Cotton-seed meal eaten		897.	786.21	1272.3	1138.
More fed than eaten in 96⅜ days,	hulls	112.7	60.2		
	meal	2.75	1.35		
More fed than eaten in 135 days,	hulls			145.6	134.5
	meal			78.0	130.5
Daily rations eaten for entire experiment,	hulls	17.2	15.6	14.1	12.4
	meal	9.3	18.	9.6	8.3
Valuing cotton-seed hulls at $3 and meal at $24 per ton, with 66 cents for hauling, and calculating on what was fed to each steer, the balance is,		Net loss $0.28	Gain $ .70	Loss $10.17	Loss $6.03
But on the basis of what was eaten, the balance is,		Net loss $0.07	Gain $.81	Loss $7.08	Loss $4.82

These were long feeding periods for animals in the condition in which these were at the beginning of the experiment. Steers Nos. 1 and 2 gave a net profit of 74 cents on basis of cost of food for 96 days' feeding; $3.12 for 81 days' feeding, and $5.71 for 63 days' feeding Steers 3 and 4, on the heavier ration of hulls and meal, gave a net loss of $11.90 on basis of cost of food eaten for 135 days, while for 40 days' feeding there was a profit of $1.83. Steer No. 3 first showed loss in the period of 22 days from the 40th to the 62d day, while No. 4 had only lost $0.05 after 81 days. Perhaps, then, one of the most valuable points in the experiments is to be found in indicating the times at which the feeding might have closed with the greatest profit to the feeder. The above figures do not take into account the cost of feeding (as to time, etc.,) and the value of the manure.

The above summary shows that, although considered fat cattle when purchased, the gain in weight and increase in value from bettered condition paid for over 40 days' feeding of No. 3 and about 80 days for No. 4, and at least 96 days for Nos. 1 and 2. A fall in the price of cotton-seed meal from the date of feeding to publication would show, on re-calculation of the cost, a net profit on No. 1 of $2 42 or $2.62, and on steer No. 3, a gain of $3.06 or $3.17, according as the food fed or eaten is made the basis of calculation. The same re-calculation for steers Nos. 3 and 4, would show a reduction of the loss to $6.12 or $2.26 for No. 3, and $3.80 or $3.42 for No. 4. Had the feeding been stopped earlier, the results would have been more favorable. The heavy rations are thus shown to have been profitable with these half fat cattle only for two or three periods, comprising 40 to 63 days. A much poorer ration could not have been depended on for profit from the best conditioned steers. They had been pre-

viously fed and were to be sold as fat cattle. Any further feeding must have been better than the former in digestible matter, in order to support the weight already attained and to add more to it. The rations here fed, proved to have been equal to the demand, as a profit accrued from the 40 to 60 days' feeding. A table of rations was calculated for each steer in every period, showing length of period, average weight for each period, pounds of hulls and meal eaten, dry matter per 1,000 pounds, and the digestible protein, carbohydrates, and fat eaten by each animal. These are given in detail in the complete record of the test in the complete bulletin herewith. The pounds of nutritive substance per 1,000 pounds, the nutritive ratio, actual daily gain, and gain per 1,000 live weight are also included.

The Temperature of the Stable.

With this experiment, an accurate record of the temperature of the stable has been taken by a Draper's Self-recording Thermometer. Our climate is temperate and housing stock tends to level the range of temperature. Yet there has occurred quite a range of temperature, and cold has been intense enough to freeze in the stable and make it an uncomfortable place. During the feeding reported in this bulletin, the following temperatures and averages in degrees Fahrenheit were recorded:

	1st Period.	*2d Period.*	*3d Period.*	*4th Period.*	*5th Period.*	*6th Period.*	*7th Period.*
Average daily temperature	48.9	48.9	55.1	60.8	61.0	69.8	71.9
Average maximum daily temperature	60.	64.8	65.1	77.0	73.	76.4	81.0
Average minimum daily temperature	35.1	37.4	33.2	38.8	52.4	59.8	61.3
Highest temperature reached	66. Jan. 24	70. Feb. 9	71. Mar. 8	85.5 Mar. 22	80.5 April 19	85. May 2	89.5 May 18
Lowest temperature reached	33.5 Jan. 26	32.5 Feb. 5	30. Feb. 25	33. Mar. 27	47. Apr. 11	54. Apr. 24	54. May 20
Range of temperature	32.5	37.5	41.	52.5	33.5	31.	35.5

The greatest range within a short time was occasioned by the March freeze, when from the 22d to the 27th, the thermometer indicated a range of temperature of 52.5° F. The close approximation to the freezing point in each of the first four periods indicate that stock would suffer if not well housed.

Water Required per Pound of Dry Matter of Food.

Some notes additional to those heretofore reported have been recorded from these experiments. The steers consumed daily an average of 2.96 to 3.42 pounds of water for each pound of dry matter during their whole feeding time. More water was required during the warm than the cool periods. There is no regular relation here between the gain and ratio of water to dry matter consumed.

Digestibility of the Rations.

An average of 55 per cent. of the dry matter was digested in the ration of 2 pounds of hulls to 1 of meal, and 56 per cent. of the ration of 1½ pounds of hulls to 1 of meal This is a good rate of digestibility, especially when the low digestibility of hulls is considered. To ascertain how the food actually digested in these rations would compare with the amount indicated to be digestible by calculating on a basis of the coefficients of digestibility of the single foods, the digestible matter in the ration of steer No. 2 (2 of hulls to 1 of meal) for the third period was calculated in the usual way, by using the coefficients of the single foods, and compared with what was actually digested in the ration. The actual digestibility of protein and fat were found to be less than the usual method of calculation would indicate, while the carbohydrates were sufficiently more digestible in the rations to increase the total digestible substance in the daily ration nearly one-half pound. Carrying this calculation to 3,000 pounds food, one ton of hulls and one-half ton of meal, there would be a gain of about 50.7 pounds digestible nutrients in the combinations as actually digested over the calculated results. This would argue that cotton-seed meal has favorably affected the digestibility of cotton-seed hulls in the rations.

Does Cotton-seed Meal Affect the Digestibility of Cotton-seed Hulls?*

Using the coefficients for cotton-seed meal† obtained by us, the digestibility of cotton-seed hulls in the various rations with meal has been calculated. The calculated digestibility of the hulls in the rations is greater, in every case, and in some instances materially more, than the average of four determinations show them to have been when fed alone. There has been a decided retardation in the digestibility of protein in every case, due to the combinations. But the loss in protein is more than counterbalanced by the increased digestibility of carbohydrates. The gains in nitrogen-free extract and crude fiber were sufficient, after bringing up the loss from protein to increase the digestible dry matter from .81 per cent. in the 7 to 1 ration of hulls and meal, to 8.66 per cent. in the 3 to 1 ration. This is quite a decided and important increase. In the light of these experiments, we cannot but answer otherwise than that cotton-seed meal does affect and increase the digestibility of cotton-seed hulls.

Fertilizing Constituents of Rations of Cotton-seed Hulls and Meal Recovered in the Manure.

It is often stated that the largest, and not infrequently the only profit, from feeding fattening animals, is in the judicious handling of

*For similar discussion and data relating to corn silage, see N. C. Experiment Station Bulletin 97, p. 123.

†N. C. Experiment Station Bulletin 97, p. 116.

the manure produced. To emphasize this, the fertilizing constituents in the various rations of hulls and meal, and the proportion of them recovered in the manure, have been determined by analyzing the foods fed and the manure excreted (dung and urine.) These results show that an average of 90 per cent. of the total fertilizing constituents contained in the rations were excreted in the manure, corresponding to 89.8 per cent. of the fertilizing value; that 42.5 per cent. of these constituents were contained in the urine, corresponding to 50.2 per cent. of the money value; while the dung contained 47.5 per cent. of the fertilizing constituents, corresponding to 39.6 per cent. of the original manurial value of the rations. These figures make apparent the value of urine as a fertilizer, especially where nitrogenous rations are fed. The urine is especially rich in nitrogen and potash, while most of the phosphoric acid is contained in the solid excrement. The average value of the urine per day for five animals was 7.14 cents, against 5.63 cents for the solid excrement for the same time and animals. The value of the manure depends on the foods fed.

The obtainable manurial value of the rations is in all cases materially greater than the original cost of the foods making the rations. The average cost of the daily rations of the five animals was 9.53 cents, valuing cotton-seed meal at $18.00 and hulls at $3.00 per ton. The average total manurial value of the same rations was 14.22 cents, and the obtainable manurial value 12.77 cents. The obtainable manurial value of the rations (12.77 cents) is 134 per cent. of the original cost of the rations (9.53 cents). It is as though the growth and fattening of the animals were obtained for nothing and there was still a balance of 34 per cent. of the original cost of the foods in the manure pile to the credit of the feeder. These results would not be obtained in ordinary practice, since no account is taken of the unavoidable loss in handling and resulting from decomposition. Neither do these figures take into account the cost of feeding and applying the manure to the land.

[The previous pages present a condensed Summary of the several subjects treated in this Bulletin. The detailed and technical account can be found in the following pages (225 to 253). Persons who do not receive these latter pages can be supplied by making application to Dr. H. B. BATTLE, Director, Raleigh, N. C.]

COTTON-SEED HULLS AND MEAL FOR BEEF PRODUCTION.

Since October, 1889, experiments have been conducted by this Station each year to develop some new phase of the subject.* In connection with these experiments, digestion experiments have also been made, and the digestibility of the rations fed have been determined. The various rations so tested have ranged from cotton-seed hulls alone, and 7 pounds of hulls to 1 of meal down to 1½ of hulls to 1 of meal, which is reported in the present bulletin. The heaviest feeding of cotton-seed meal yet attempted (rations of 2 pounds of cotton-seed hulls to 1 of meal and 1½ of hulls to 1 of meal) for any considerable time so far as known has been successfully completed and the work is reported in the present bulletin. The results surpass expectations in respect to the large amount of meal consumed for a long period with no perceptible effect upon the health of the steers. This exceptionally heavy feeding was not economical to the extreme to which it was carried.

THE STEERS, AND THE RATIONS FED TO THEM.

Steer No. 1.—This was a mature ox, which had been worked. He was of a decidedly beefy form and was quiet and docile in confinement.

Steer No. 2.—This was also a mature ox, that doubtless had done much work. The narrow sloping shoulders, high spine, narrow hips, and sharp angular appearance indicated other than the kindly feeder, yet this steer ate his rations well and made a very creditable gain in weight.

Steers Nos. 3 and 4.—These were young, 2½ to 3½ years old. They were from southwestern Virginia, showed no appearance of having been worked, and were apparently grade shorthorns, though of a long-legged type. No. 3 was evidently older than No. 4 and weighed at beginning of this experiment 135 pounds more than did No. 4.

All four steers were being fed a fattening ration of cotton-seed hulls and meal, when purchased from a firm in Raleigh, and were therefore put at once on heavy rations. These rations were composed of ordinary commercial cotton-seed hulls and meal, purchased from the Raleigh Oil Mills. Presumably they are the same at every mill, allowing some small differences in the cleanness of the operation of freeing the kernels of the cotton-seed from the hulls. These were intended to be fed to steers Nos. 1 and 2, in the proportion of two pounds of hulls to one pound of meal, and in quantity sufficient

*See N. C. Experiment Station Bulletins, 81, 80c, 87d, 93, 97, 106, and 109.

TABLE I.—Results of Feeding Steers Nos. 1 and 2 on Cotton-seed Hulls and Meal for five Periods.

No. of Period.	Date.	Kind of Feed and Rate Fed.	Number of days in period.	Total hulls eaten.	Total meal eaten.	Total water drank. A. M.	Total water drank. P. M.	Aver'ge water drank daily.	Average fasted live wt. taken every morning.	Average of 3 Weights. Beginning of period.	Average of 3 Weights. End of period.
				Pounds.	Pounds	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
		Steer No. 1.									
1	Jan. 9–29, '94	Cotton-seed hulls and meal, 2:1	20⅔	332.2	194.4	218.5	921.5	56.16	1058.0	1050 0	1065.5
2	Jan. 30, Feb. 18, '94	Cotton-seed hulls and meal, 2:1	20	355.0	187.9	218.5	1074.5	64.65	1093.6	1065.5	1122.0
3	Feb. 19, Mar. 12, '94	Cotton-seed hulls and meal, nearly 2:1	22	378.3	209.0	290.5	1250 0	70.02	1138.0	1122.0	1165.2
4	Mar. 13–31	Cotton seed hulls and meal, 2:1	19	328.7	171.0	345.0	1001.0	70 84	1176.0	1165.2	1211 3
5	April 1–15	Cotton-seed hulls and meal, 2:1	15	267.1	134.7	271.5	853.5	75.00	1208.3	1211.3	1223.0
		(Digestion periods 94 to 95th days)	96⅔	1661.3	897.0	1344.0	5100.5	......	5673.9	5614 0	5787.0
		Average daily weights	......	17.2	9 3	13.9	52 85	......	1135.8		
		Steer No. 2.									
1	Jan. 9–29, '94	Cotton-seed hulls and meal 2:1	20⅔	253.7	150 2	176.0	795.5	47.01	911.0	902.7	915.3
2	Jan. 30, Feb. 18, '94	Cotton seed hulls and meal, 2:1	20	300 0	149 0	113.0	998 5	55.58	949.3	915.3	973 0
3	Feb. 19, Mar. 12, '94	Cotton seed hulls and meal, 2:1	22	374.0	187.0	147.0	1344.0	67.77	1010.7	973.0	1022.7
4	Mar. 13–31	Cotton seed hulls and meal, 2:1	19	337.3	171.0	348.5	1026.0	72.34	1040.8	1022.7	1064 3
5	April 1–15	Cotton-seed hulls and meal, 2:1	15	243.8	128.9	275.0	699 5	64.97	1066.6	1064.3	1087.7
		Total	96⅔	1508.8	786.15	1059.5	4663.5	......	4978.4	4878.0	5063.0
		Average per day		15.6	8.13	10.96	48.24	......	995.7		

to be considered *ad libitum* feeding, yet not enough to produce surfeit, in a short time. As fed, steers Nos. 1 and 2 received rather too much, at first, and the amount of food was reduced in the amounts fed per day, and then advanced. No. 3 was fed in nearly the same way except in different proportions, while No. 4 was fed at the beginning with a little less than his appetite demanded, and a slight advance in his case was the only change required. These two steers, Nos. 3 and 4, were fed a ration consisting of 3 pounds of hulls to 2 pounds of meal. The feeding began Jan. 9th, 1894 and continued, for Nos. 1 and 2, until after the close, in Period 5, of the second four days of collections for the digestion experiment recorded elsewhere. For Nos. 3 and 4, the collections were made in the 5th and early part of the 6th periods, and these steers were fed through a seventh period of twenty-one days for purposes of observation. The rations were all eaten with relish, until in the last seven days of the seventh period, when both steers left considerable amounts of food uneaten, and No. 3 practically stopped eating.

During this last period, it will be noted that No. 3 continued to gain in weight up to the time he lost appetite, (colloquially, "off his feed") and that the loss recorded below was rather a loss of stomach contents than a real loss of flesh. This may be readily seen from the weight of ingesta immediately before and during the last seven days.

During the 5th and 6th periods, and 14 days of the 7th period, the food and water consumed by steer No. 3, compared with what was taken on the last seven days of the 7th period, are as follows:

	Food Consumed per Day, Lbs.	*Water Drank per Day, Lbs.*	*Total Amount Digested per Day, Lbs.*
5th Period	23.625	70.52	94.145
6th Period	23.575	78.82	102.395
7th Period, 14 days	20.807	73.46	94.267
7th Period, 7 days	9.357	48.00	57.357

This shows a daily difference of about 37 pounds, which leaves 21.5 pounds of loss, which may be due to excess of excreta over ingesta.

These steers were regarded as among the best received at the Raleigh market for the season when they were slaughtered and exposed for sale.

Results of Feeding Steers Nos. 1. and 2.

Table I shows the summaries of the very painstaking work in the stable to secure accurate results with steers Nos. 1 and 2. In the details of the stable work with these steers over 1,125 separate weights were made for the food, water, and live weight, and many more for each small amount of waste which could be found to take out and weigh. The table shows the date of each period, the ratio of hulls to meal as fed, the number of days in each period, the amounts of hulls and meal eaten, and water drank by periods, also the average

live weights from daily weighings before being fed or watered, and the average weights at the end of each period taken from these weights—the first day of the period combined with the two next previous weights. Table III shows similar data for steers Nos. 3 and 4.

The following weights of hulls and meal were fed to steers Nos. 1 and 2:

	Steer No. 1.	*Steer No. 2.*
Cotton-seed hulls	1775.0 lbs.	1569.0 lbs.
Cotton-seed meal	899.7 "	787.50 "
Amounts eaten (see Table I): Hulls	1661.3 "	1508.8 "
Meal	897.0 "	786.1 "
More fed than eaten in 96⅔ days: Hulls	112.7 "	60.2 "
Meal	2.7 "	1.3 "

This is considered close feeding for three months.

These steers were purchased at 2¾ cents as half fat cattle. The average of three fasted weights was the basis of weight, which is given in the above table at column 10, for each steer. Reckoning cotton-seed hulls at $3, and meal $24* per ton, and hauling same $ 50 per trip for about fifteen to seventeen hundred pounds, the following statement may be made, showing the cost and net profit or loss from feeding each steer, when charging for all that was fed to each, and also the same based on what was eaten by each steer.

TABLE II.—Summary of Results with Steers Nos. 1 and 2.

	STEER NO. 1.				STEER NO. 2.			
	Amount fed. Lbs.	Value. $	Amount eaten. Lbs.	Value. $	Amount fed. Lbs.	Value. $	Amount eaten. Lbs.	Value. $
Cotton seed hulls	1775.	2.66	1661.3	2.49	1569	2.35	1509.	2.26
Cotton-seed meal	900.	10.80	897.0	10.76	7875.	9.45	786.	9 43
Cost of hauling	...	.75	......	.75	..	.75	...	.75
Value of steer at beginning, at 2¾c.	1050	28 88	.....	28 88	903	24.83	...	24.83
Total cost	...	43.09	......	42 88	..	37.38	...	37.27
Value of steer at close of experiment at 3½c. per pound	1223	42 81	......	42.81	1088.	38.08		38.08
Net balance	Loss	.28	Loss	.07	Gain	.70	...	.81

Net gain on both steers, $.42 or .74.

* From the date of this feeding to the date of publication there has been a fall of $6 per ton in the price of cotton-seed meal, which can now be purchased at $18 per ton. A recalculation of table II. using $18 per ton instead of $24 per ton for meal, shows the net profits increased for steer No. 1, to a gain of $2.42 or $2.62; and for steer No. 2, to a gain of $3.06 or $3.17, according to whether the amount fed or eaten was used as the basis of calculation.

If these steers had been regarded fat enough to be worth 3½ cents per pound at the end of the 4th period, the only difference would

have been a small reduction in weight and the cost of 15 days feeding—which was, for No. 1, 270 pounds of hulls, worth 40.5 cents, and 135 pounds of meal, worth $1.62. For No. 2, the cost was for 258 pounds of hulls, worth 38.7 cents, and 129 pounds of meal, worth $1.548. Total, $3 96. The difference in weight would reduce value of No. 1 $.42 and No. 2 $.84. This would have given a net profit of $3.12 for the 81 days feeding at the prices actually paid for feed.

Suppose, again, that the steers had been fat at the end of the 3d period, which was true of No. 1, we should reduce the selling values of No. 1 to $40.78; No. 2, $35.81, while the cost of food offered them would amount to: No. 1, $8.87; No. 2, $7.30. To have closed this feeding on the 63 day would have given a net return on No. 1 of $2.53 and on No. 2 of $3.18, or $5.71 on both, when pay for one trip of team for food for each steer has been deducted.

Results of Feeding Steers Nos. 3 and 4.

Table III gives data for steers Nos. 3 and 4 similar to that just discussed for Nos. 1 and 2. These were thrifty young steers and were fed heavy rations for a very long period. Taking into consideration the condition of the steers at the beginning of this experiment, it is a matter of note that they continued for so long a time to consume and assimulate so much rich food.

The change of location almost invariably produces a loss in weight. No. 3 lost 17.7 pounds for the first 20⅔ days, and a reference to the daily weights shows that the average of three weights first exceeded the first three only on the 24th day of feeding. But this was not wholly due to change of environment, as the quantity of water drank, and the time it was taken on the previous day, largely controls the changes of weight from morning to morning*.

For account of the loss of weight during last period, see above.

Steer No. 4 gained steadily from beginning to end of the experiment. The increase in the first period shows this steer was less affected by changes of environment than was No. 3. The total gain in weight was 1.53 pounds per day. This was largely growth independent of fattening, but this steer, as well as No. 3, was in exceptionally good condition for this market. Both steers were fed so far beyond the point of profit, financially, that it will be interesting to turn back and point out what would have been the result at the end of several periods. This may, perhaps, prove the most valuable part of the results obtained, by showing the place at which the feeding might have been stopped with the largest balance on the credit side. Making calculations as in the case of steers Nos. 1 and 2, the following results contained in table IV. have been obtained on amounts fed and eaten during the whole time.† Below the table are results for other periods.

* N. C. Experiment Station Bulletin, 93, p. 33, *et seq.*

† The expense reduced from feeding cotton-seed meal at $18 per ton instead of $24 per ton calculated on Steers Nos. 3 and 4 the same as for the first pair, results as follows: Net loss on No. 3, reduced to $6.12 or $3.26; on No. 4, reduced to $3.80 or $3.42.

TABLE III.—Results of Feeding Steers Nos. 3 and 4 on Cotton-seed Hulls and Meal for seven Periods.

No. of Period.	Kind of Feed and Rate.	Number of days in period.	Total hulls eaten. Pounds.	Total meal eaten. Pounds.	Total water drank. A. M. Pounds.	Total water drank. P. M. Pounds.	Aver'ge water drank daily. Pounds.	Average fasted live wt. taken every morning. Pounds.	Average of 3 Weights. Beginning of period.	Average of 3 Weights. End of period.
	Steer No. 3.									
1	Cotton-seed hulls and meal nearly 3:2	20⅔	277 6	190.2	123 5	1052.0	56 88	958.6	975.0	957.3
2	Cotton seed hulls and meal nearly 3:2	20	284.0	190.0	96.5	1127.5	61 20	988.8	957.3	1019.5
3	Cotton seed hulls and meal nearly 3:2	22	311.1	209 2	15 0	1435.0	65 91	1035.8	1019.5	1045.3
4	Cotton seed hulls and meal nearly 3:2	19	270 7	176.4	109.0	1211.0	69.47	1071.1	1045.3	1096.7
5	Cotton-seed hulls and meal nearly 3:2	20	283.9	188.6	263.0	1147.5	70.53	1109.5	1096.7	1118.2
6	Cotton seed hulls and meal nearly 3:2	20	282.6	188.9	400.0	1176.5	78 83	1142.7	1118 2	1153.0
7	Cotton-seed hulls and meal nearly 3:2	21	162.4	128 9	213.0	815.5	73.46	1166.6	1153.0	1178 3
			fed 90.7; waste 82.2*	57.0	45.0	291.0	48.00	1144.4	1178.3	1123.0
	Total	142⅔	1872 4	1272.3	1220.0	8256.0	......	8617.5		
	Average per day to May 24, '94, 135 days		14 1	9.59	9.2	62.2	......	1078.2		
	Steer No. 4.									
1	Cotton seed hulls and meal nearly 3:2	20⅔	247.4	166.2	205.5	796.0	32.31	850.3	845.8	849.2
2	Cotton-seed hulls and meal nearly 3:2	20	269.6	180 0	275.0	986.5	63 08	892.9	849.2	917.2
3	Cotton-seed hulls and meal nearly 3:2	22	295.9	198.0	208.0	1161.0	62.23	952.9	917.2	976 3
4	Cotton-seed hulls and meal nearly 3:2	19	253.2	167.06	278.5	1081.0	71.55	996.9	976.3	1030.7
5	Cotton seed hulls and meal nearly 3:5	20	264.5	179.87	243 0	1023 5	63.33	1030.4	1030.7	1043.3
6	Cotton-seed hulls and meal nearly 3:2	20	268.1	179.87	278 0	1046.0	62.20	1043.2	1043.3	1066 0
7	Cotton-seed hulls and meal nearly 3:2	14	172.2	124. nearly	327.0	676 0	71.64	1067 0	1066 0	1082.2
		7	70.0	63. nearly	118.0	309.0	61 00	1090.5	1082.2	1098.0
	Total	...	1771.	1178.01						
	Average per day to May, 24, '94, 135 days	..	12.41	8.25						

* Waste hulls and meal.

TABLE IV.—Summary of Results with Steers Nos. 3 and 4.

	STEER NO. 3.				STEER NO. 4.			
	Amount fed. Lbs.	Value. $	Amount eaten. (to May 25th.) Lbs.	Value. $	Amount fed. Lbs.	Value. $	Amount eaten. (to May 25th.) Lbs.	Value. $
Cotton-seed hulls	2018 0	3.03	1872.4	2.81	1905.5	2.86	1771.	2.66
Cotton-seed meal	1350.0	16.20	1272.3	15 27	1268.5	15.22	1138.	13.66
Cost of hauling	......	1.00	......	1.00	......	1.00	....	1.00
Value of steer at beginning, at 3c. per pound	......	29.25	......	29.25	......	25.38	....	25.38
Total cost	......	49.48	......	48.33	....	44.46	....	42.70
Value at close of experiment, at 3½c per pound	......	39.31	....	41.25	......	38.43	...	37.88
Balance, net loss	......	10.17	......	7.08	-- --	6.03	....	4.82

TABLE V.—Condensed Summary of Losses and Gains by Periods, provided the Steers had been sold as fat at the end of each Period.

	STEER NO. 3 — Value at beginning, $29.25.				STEER NO. 4 — Value at beginning, $25.38.			
	Cost of hulls and meal. $	Total cost. $	Value of steer at close. $	Net result. Gain.+ Loss.— $	Cost of hulls and meal. $	Total cost. $	Value of steer at close. $	Net result. Gain.+ Loss.— $
6th Period	17.15	46 40	40 36	—6.04	16.14	41.52	37 31	—4.21
5th Period	13.98	43.23	39.13	—4.10	13.58	38.96	36.52	—2.44
4th Period	10.88	40.13	38.40	—1.73	10.76	36.14	36.09	—0.05
3d Period	8.91	38.16	36.59	—1.57	8.20	33 58	34.16	+0.58
2d Period	5.97	35.22	35.68	+ .46	5.25	30.63	32.10	+1.47

This summary shows that although considered fat cattle when purchased, the gain in weight and increase in value from bettered condition, paid for over 40 days' feeding of No. 3 and about 80 days for No. 4.

The heavy rations are thus seen to have been profitable only for two or three periods, comprising 40 to 63 days. A poorer ration

could not have been depended on for profit from the best conditioned steers. They had previously been fed up to a point where they were turned out as fat. Any further feeding must be better than the former in amount of digestible matter, in order to support the weight already attained and to add more to it.

Digestible Food Consumed.

The rations fed proved to be equal to the demand. The accompanying table, No. VI., shows the amount of digestible food consumed by each steer per day during all of the periods.

The first period was taken from the day the steers came to the Experiment Farm barn, and as a consequence of change of environment, there was a falling back in rate of gain, which proved an actual loss on one steer for the first period of $20\frac{2}{3}$ days. The other steers were checked, but not so much as to show a loss. The columns showing gains in weight indicate very satisfactory gains in periods 2, 3, and 4, while in no period, save the last third of period 7, for steer No. 3, when he had stopped eating, was there any loss of weight after the steers became accustomed to their surroundings. The gains were smallest in the first and fifth periods. This was, doubtless, due chiefly to change of stables in the first period, as noted above, and to handling and presence of a watcher in the digestion experiments during the fifth period for all steers, and the sixth period for Nos. 3 and 4.

The rations calculated in table VI. are derived from the digestion work reported below, and are based on the average weights of steers and average rations consumed for whole periods. They are the nearest approach to actual amounts digested that we are able to make. It may be noted that steer No. 2 ate the whole of the ration offered him in period three. This has been calculated (Table VII.), using the coefficients for hulls and meal separately,* and a comparison made with the ration in the table, which is calculated by use of the co-efficients from the digestibility of the ration in period five. This comparison shows the retarding effect of the coarse fodder on the digestibility of protein, and of its effect to increase that of the carbohydrates.

Here the protein and fat lose, but the carbohydrates gain more than double the amount of loss in weight of protein and fat. The ratio is also wider, as would be expected.

This ration differs widely in all respects from the German Standard. There is less dry matter, less digestible substance, less carbohydrates, but more fat and more protein. Carrying the difference in the above ration to 3000 pounds of food, one ton of hulls and half a ton of meal, there appears to be about 50.7 pounds more digestible food from using coefficients of digestibility of the ration than from

* Bulletin 90, p. 10.

TABLE VI.—Digestible Food Consumed by the four Steers during each of the Periods.

		Aver'ge weight during period.	Pounds eaten, as pounds fed, less pounds waste.		Dry matter consumed per day and 1000 pounds live weight.	Pounds of digestible nutrients consumed per day, and 1000 pounds.					Actual daily gain.	Daily gain per 1000 pounds weight.
			Cotton-seed hulls.	Cotton-seed meal.		Protein.	Carbo-hydr'tes	Fat (ether Extract.)	Nutritive Substance.	Ratio 1 to		
		Pounds.					Pounds	Pounds.	Pounds.		Pounds.	Pounds.
First Period (20⅔ days)	No. 1	1058.0	16.07	9.40	21.56	2.991	7.258	1.320	11.569	3.53	.750	.709
	No. 2	911.0	12.27	7.27	19.21	2.681	6.453	1.179	10.313	3 51	.610	.669
	No. 3	958.6	13.43	9.20	21.17	3.202	7.149	1.347	11.698	3.29		
	No. 4	850.3	11.97	8.04	22.17	3.494	7.357	1.432	12.283	3.13	.165	.193
Second Period (20 days)	No. 1	1093.6	17.75	9 39	22.20	2.944	7.597	1 339	11.880	3.72	2.825	2.583
	No. 2	949.3	15 00	7.45	21.14	2.724	7.306	1.262	11.292	3.84	2.885	3.039
	No. 3	988 8	14.20	9.50	21.48	3 214	7.285	1.362	11.861	3 32	3.110	3.145
	No. 4	892.9	13.48	9.00	22.56	3.373	7.655	1.430	12.458	3.32	3.400	3.808
Third Period (22 days)	No. 1	1138.0	17.19	9.50	20.99	2.838	7.133	1 274	11.245	3 64	1.964	1.726
	No. 2	1010.7	17.00	8.50	22.56	2.916	7.787	1.348	12.051	3.83	2.259	2.235
	No. 3	1035.8	14.14	9.51	20.47	3.070	6.935	1.299	11.304	3.32	1.173	1.132
	No. 4	952.9	13.45	9.00	21.12	3.160	7.160	1.338	11.658	3.32	2.686	2.819
Fourth Period (19 days)	No. 1	11760.	17.30	9.00	20.00	2.632	6.866	1.203	10.701	3.75	2.426	2.063
	No. 2	1040.8	17.75	9.00	22.98	2.989	7.916	1.376	12.281	3.80	2.189	2.104
	No. 3	1071 1	14.25	9 28	19.69	2 913	6.707	1.243	10.863	3.37	2.705	2.526
	No. 4	996.9	13.33	8.79	19.89	2.958	6.761	1.258	.0.977	3.35	2.863	2.870
Fifth Period (*15 days for Nos. 1 and 2*), (*20 days for Nos. 3 and 4*)	No. 1	1208.3	17.80	8 98	19.82	2.572	6.834	1.187	10.593	3.81	.585	0.484
	No. 2	1066.6	16.25	8 59	20.84	2.762	7.130	1.256	11.148	3.72	1.170	1.097
	No. 3	1109.5	14.19	9.43	19.08	2.846	6.479	1.194	10.519	3.32	1.075	0.969
	No. 4	1031.4	13.22	8.99	19.31	2.910	6.529	1.227	10.666	3.29	0.630	0.611
Sixth Period (20 days)	No. 3	1142.7	14.13	9.44	18.49	2.765	6.221	1.172	10.158	3.31	1.740	1 523
	No. 4	1063.2	13.40	8.99	18.89	2.830	6 401	1.197	9.816	3.32	1.135	1.068
a. *Seventh Period* (14 days)	No. 3	1166.6	11.60	9.20	16.01	2.575	5.265	1.042	8.882	3.06	1.807	1.549
	No. 4	1067.0	12.32	8.85	17.80	2.747	5.960	1.133	9.840	3.20	1.157	1.084
b. *Seventh Period* (7 days)	No. 3	1144.4	....	....	....	....	....	....	....	....		
	No. 4	1090.5	10.00	9.00	15.66	2.692	5.502	1.089	9.283	....	2.257	2.070

TABLE VII.—Ration of Steer No. 2 in Period 3. (Calculated in the usual way.)

	Total dry matter. Lbs.	Digestible Constituents. Protein. Lbs.	Carbohydrates. Lbs.	Fat. Lbs.	Nutritive substances.	Ratio, 1 to:—
Cotton-seed hulls (17 pounds)	15.009	0.054	5.390	0.649	....	......
Cotton-seed meal (8.50 pounds)	7.793	3.189	1.715	0.750	....	......
	22.802	3.240	7.106	1.399	11.749	3.27
Rations reduced to 1000. lbs. live weight	-- ---	3.200	7.031	1.385	11.625	
Same ration, but coefficients derived from digestion of ration B.	22.802	2.947	7.870	1.362	12.179	
Ration reduced to 1000. lbs. live weight	....	2.916	7.787	1.348	12.051	3.83
Difference less (—) than by usual method, or more (+)		−0.293	+.756	−.037	+.426	
German Standard for 3d period per 1000. pounds live weight	25.00	2.70	14.80	.60	18.10	6.00

those of the hulls and meal taken singly. This amount of digestible food was gained by combining the hulls and meal.

Temperature of the Stable during these Experiments.

Heretofore we have made no record of the temperature of the stable during feeding experiments. Our climate is temperate and housing stock tends to level the changes that occur, but there is a considerable range of temperature, even in a comfortable barn, as is shown by the following record made during this feeding by a Draper's Self-Recording Thermometer.

This thermometer was placed in the main part of the stable at noon, January 13th, 1894, and the record has since been kept continuously, all changes being accurately recorded at the time they occurred.

The table herewith (VIII) has been compiled from the record by taking the temperature to the nearest half degree on the hour lines of the weekly record charts. Thus the daily temperature for every day, except January 13th, is the mean of the temperature at 24 hourly readings. Below, in table VIII, are given the mean tem-

TABLE VIII.—Daily Temperature of Stable (from noon January 13 to and including May 31, 1894.)

Period 1.		Period 2.		Period 3.		Period 4.		Period 5.		Period 6.		Period 7.	
Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.	Date, 1894.	Mean daily temperature °F.
Jan.		Jan.		Feb.		Mar.		Apr.		Apr		May	
10		30	43.4	19	61.6	13	57.1	1	64.5	21	66.6	11	76.0
11		31	50.6	20	60.6	14	61.3	2	58.0	22	60.7	12	75.6
12		Feb.		21	62.3	15	61.3	3	53.9	23	59.8	13	76.5
13	51.0	1	55.4	22	49.3	16	69.1	4	62.1	24	62.2	14	76.1
14	52.8	2	46.8	23	46.6	17	66.2	5	65.1	25	62.8	15	77.1
15	55.9	3	54.8	24	38.7	18	66.5	6	55.6	26	64.7	16	76.5
16	60.0	4	53.4	25	33.2	19	72.9	7	60.9	27	69.6	17	79.4
17	54.0	5	38.4	26	40.1	20	74.0	8	65.6	28	73.3	18	81.0
18	50.5	6	44.3	27	46.2	21	75.7	9	56.9	29	71.5	19	71.4
19	51.4	7	48.2	28	49.3	22	77.0	10	52.4	30	65.9	20	61.3
20	46.2	8	56.3	Mar.		23	73.1	11	52.4	May		21	64.0
21	47.9	9	64.8	1	54.4	24	71.6	12	52.5	1	65.9	22	70.3
22	47.6	10	62.5	2	56.5	25	58.4	13	56.4	2	71.9	23	68.7
23	48.0	11	56.0	3	55.5	26	41.6	14	58.9	3	74.6	24	67.0
24	57.7	12	56.7	4	56.7	27	38.8	15	60.8	4	76.4	25	67.1
25	44.1	13	51.3	5	60.2	28	45.2	16	63.3	5	75.0	26	70.6
26	35.1	14	44.5	6	64.0	29	49.4	17	68.8	6	73.2	27	72.8
27	40.3	15	41.9	7	65.0	30	48.5	18	68.2	7	75.9	28	74.4
28	42.5	16	37.4	8	65.1	31	57.7	19	73.0	8	76.1	29	65.9
29	46.5	17	44.7	9	65.0			20	70.6	9	74.8	30	69.5
		18	56.8	10	61.0					10	71.9	31	69.4
				11	62.3								
				12	58.1								
M'ns	48.9		48.9		55.1		60.8		61.0		69.8		71.9

	Period 1.	Period 2.	Period 3.	Period 4.	Period 5.	Period 6.	Period 7.
Highest mean daily temperature	60.0	64.8	65.1	77.0	73.0	76.4	81.0
Date	Jan. 16	Feb. 9	Mar. 8	Mar. 22	April 19	May 4	May 18
Lowest daily mean temperature	35.1	37.4	33.2	38.8	52.4	59.8	61.3
Date	Jan. 26	Feb. 16	Feb. 25	Mar. 27	April 10 and 11	April 23	May 20
Highest temperature recorded	66.0	70.0	71.0	85.5	80.5	85.0	89.5
Date and hour	5 p. m. Jan. 24	2, 5 p.m. Feb. 9	6, 7 p. m. Mar. 8	5 p. m. Mar. 22	5 p. m. April 19	6 p. m. May 20	4 p. m. May 18
Lowest temperature recorded	33.5	32.5	30.0	33.0	47.0	54.0	54.0
Date and hour	3, 7 a.m. Jan. 26	7, 9 a.m. Feb. 5	2, 9, 10, 11 a. m. Feb. 25	8 a. m. Mar. 27	7, 8 a m. April 11	7 a. m April 24	8 a. m. May 20

perature for each period and the mean maximum and minimum daily temperatures, while the extreme maximum and minimum temperatures which occurred in each period are shown, with the dates and hours of their occurrence.

This constant record shows a considerable range of temperature from below freezing on February 25, to 89.5° F. on May 18. The greatest range in a short time was between March 22 and March 27, was 52.5° F. The close approximation to the freezing point in this stable during each of the periods 1, 2, 3 and 4, indicate that stock would suffer from cold if not well housed here, and that even with comfortable stables the temperature may go down to a point where profitable gain in flesh, or in flow of milk, is jeopardized. But here the low temperatures were not of long duration, the longest being on February 25th, and it seems to have had no effect on the yield of milk in the Station herd of cows with exception of two individuals from which less was obtained on that day. One steer changed from drinking at night to morning on that day which may have been induced by the agreeable higher temperature of water above air. This with much less water taken at night gave a loss of weight the next morning. The mean daily temperature ranging from 48° to 72° F. was accompanied by good appetites in the steers being fed, until May 24th, at that time appetite began to fail and the high temperature was probably one of the causes for it. The rising of the temperature also may have had some effect in increasing the consumption of water drank by the steers.

Notes on the Amount of Water Required per Pound of Dry Matter of Food.

In two previous bulletins* there have been recorded some notes on the amounts of water required by steers, with a given amount of dry matter, but the weights of water were only taken for about one fifth of the time while the average weights of the steers were being taken. During the feeding here recorded, the steers and water drank by them have been weighed (see table IX) as regularly as the food. There are some variations in the amount of water consumed per pound of dry matter of food, but these are less where total quantities are known than were shown by the results obtained† when the weights were taken only for a portion of the time.

The greatest variation found has been with steer No. 4, where there was less regularity found in the increase of water to dry matter as the weather became warmer, than with the other steers. That this increased demand for water was probably the result of greater evaporation, due to the rising temperature and probable falling humidity of the atmosphere, may be assumed from inspection of table X.

* N. C. Experiment Station Bulletins, Nos. 81 and 93.

† Bulletin 93, p. 40.

TABLE IX.—Proportional Amounts of Water Consumed per Day and 1000 Pounds Live Weight.

Number of Period.	Daily Average for Steer No. 1.					Daily Average for Steer No. 2.				
	Total dry matter.	Water in food.	Water drank.	Total water.	Pounds water for one of dry matter.	Total dry matter.	Water in food.	Water drank.	Total water.	Pounds water for one of dry matter.
	Lbs.	Lbs.	Lbs.	Lbs.		Lbs	Lbs.	Lbs.	Lbs.	
1	21.564	2 519	53.081	55 600	2.578	19.213	2.242	51.603	53.845	2.803
2	22.206	2.615	59.117	61 732	2 780	21.146	2 503	58.548	61.051	2.887
3	20 994	2 464	61.529	63 993	3.048	22.566	2.669	67.053	69.722	3 090
4	20 007	2 775	60.238	63.013	3.150	22.984	2.717	69.504	72.221	3.142
5	19 825	2.344	62.071	64.415	3.249	20.840	2.455	60.904	63.359	2.896
Mean	20 919				2.961	21.350				2.964
	Daily Average for Steer No. 3.					**Daily Average for Steer No. 4.**				
1	21.176	2 339	59.337	61.676	2.913	22 179	2.079	56 992	59.071	2.663
2	21.488	2.453	61.893	64.346	2 995	22.569	2.327	70.646	72.973	3.233
3	20 473	2.363	63 632	65 995	3.224	21.121	2 439	65.306	67.745	3.207
4	19 693	2.441	64.859	67 300	3 417	19.892	2.292	71.772	74.064	3.723
5	19 088	2.205	63.569	65.774	3 446	19.315	2 297	61.373	63.670	3.296
6	18.495	2 452	68.986	71.438	3 863	18.891	2.318	58.503	60.821	3.220
7a	16 015	2.124	62 969	65 093	4.065	17.805	2.176	67.142	69.318	3 893
7b	--- ---	----	--- --	------		15 663	1.920	55.938	57.858	3 694
Mean	19.499				3.418	19 679				3.366

TABLE X.—Showing Temperature in Stable and Amount of Water Consumed.

Number of Period.	Mean temperature.	Highest temperature.	Lowest temperature.	Amount of Water Consumed per Pound of Dry Matter of Food.			
	°F.	°F	°F.	Steer No. 1.	Steer No. 2	Steer No. 3.	Steer No. 4.
1	48.9	66.0	33.5	2.578	2.803	2,913	2.663
2	48.9	70.0	32.5	2.780	2.887	2 995	3.233
3	55.1	71.0	30.0	3.048	3.090	3.224	3.207
4	60.8	85 5	33.0	3.150	3.142	3.417	3.723
5	61.0	80.5	47.0	3.249	2.896	3.446	3.296
6	69.8	85.0	54.0			3.863	3 220
7a } 7b }	71.9	89 5	54.0			4.065	3.893 3 694
				2.961	2.964	3.418	3.366

DIGESTIBILITY OF THE RATIONS FED IN THE FOREGOING EXPERIMENTS

The digestibility of whole raw, and roasted cotton-seed, cotton-seed hulls alone, and rations of cotton-seed hulls and meal from 7 to 1 to 2 to 1, have been reported in previous bulletins* of this Station. The results here presented are in continuation and conclusion of this line of investigation of the digestibility of cotton products.

1. DIGESTION OF RATION OF TWO POUNDS OF COTTON-SEED HULLS TO ONE POUND OF MEAL.

By Steers Nos. 1 and 2.

Date of experiment, January 9 to April 15, 1894. Total period in which the ration was fed, 96⅔ days. Collection period, eight days—four days in each of the two consecutive weeks closing the feeding experiment.

Daily Rations Eaten. $\left\{\right.$ Steer No. 1, 17.2 pounds of cotton-seed hulls and 9.3 pounds of meal.
Steer No. 2, 15 6 pounds of cotton-seed hulls and 8.13 pounds of meal.

Feeds.—Previous to the beginning of each experiment, the feeding materials were thoroughly mixed separately in sufficient quantities for the entire experiments, and from these mixtures samples for analysis were taken.

Waste.—Where any waste was left during the digestion period, the total amount was saved in all cases until the end of the experiment, and sampled for analysis.

The number of days in the collection periods in these experiments have been increased beyond those in former experiments, collections having been made for eight days, four days in each of two weeks, and combined for one experiment. Results obtained by this method of collecting are less liable to be affected by variation in the amount of excrement than in shorter and continuous periods.

Analytical and other data for obtaining the coefficients of digestibility are given in tables XI. and XII.

The waste of steer No. 2 in this experiment was assumed in calculating the digestibility of the hulls in the ration to be all hulls, whereas it could be seen to contain a small amount of meal; and the analysis also reveals this, but there was not enough meal to materially increase the coefficients for hulls.

* 80*c*, 87*d*, and 97.

TABLE XI.—Showing percentage Composition of Cotton-seed Hulls and Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fats (Ether extract.)	N-free extract.	Crude fiber.
		DRY MATTER CONTAINS						
Cotton-seed meal	8.32	91.68	6.96	47.20	47.20	10.27	28.84	6.73
Cotton-seed hulls	11.71	88 29	2.79	6.16	6.16	5.45	35.56	50.04
Waste, cotton-seed hulls and meal, Steer No. 1	13.69	86.31	3.67	15.72	15 72	6.55	35.35	38.71
Solid excrement, Steer No. 1	78.65	21.35	5.77	15.85	15.85	2.23	32.79	43.36
Solid excrement, Steer No. 2	74.44	25.56	5.86	16.73	16.73	2.77	33.92	40.72

TABLE XII.—Showing Nutrients Consumed and Excreted in Ounces,* with Percentages Digested.

STEER No. 1. Ration: Cotton-seed hulls and Meal, 1.99:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS: Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fats (Ether extract.)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	2281.18	2014 05	56.19	124 07	124.07	109.77	716.20	1007.83
Cotton-seed meal fed	1146.36	1050.98	73.15	496 06	496.06	107.94	303 10	70.73
Total consumed	3427.54	3065.03	129.34	620.13	620.13	217.71	1019.30	1078 56
Total solid excrement	6384 00	1362.98	78.64	216.03	216.03	30.39	446.92	590.99
Total digested		1702.05	50.70	404 10	404.10	187 32	572.38	487.57
Digested from cotton-seed meal	------	770.37	23.04	432.07	432.07	96.82	186.41	32.82
Digested from cotton-seed hulls	------	931.68	27.66	—27.97	—27 97	90.50	385.97	454.75
Per cent. of ration digested	------	55.53	39.20	65 16	65 16	86.04	56 15	45.21
Per cent. of cotton-seed hulls digested	----	46.26	49.23	—22.54	—22.54	82 45	53.89	45.12

STEER No. 2. Ration: Cotton-seed hulls and meal, 1.81:1.

	Total amount.	Dry matter.	Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fats (Ether extract.)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	2304.00	2034.20	56 75	125.31	125.31	110.86	723.36	1017.91
Waste, cotton-seed hulls and meal†	223.00	192.47	7.06	30.26	30.26	12.61	68.04	74.51
Cotton-seed hulls consumed	2081.00	1841.73	49.69	95 05	95.05	98.25	655.32	943.40
Cotton-seed meal fed	1150.72	1054.98	73 43	497.95	497 95	108.35	304.26	71.00
Total consumed	3231.72	2896 71	123.12	593.00	593 00	206.60	959.58	1014 40
Total solid excrement	5148 00	1315.83	77 11	220.14	220.14	36.45	446 33	535.81
Total digested	------	1580.88	46.01	372.86	372.86	170.15	513.25	478.59
Digested from cotton-seed meal	------	773.30	23.13	433.71	433.71	97.19	187.12	32.94
Digested from cotton-seed hulls	------	807.58	22.88	—60.85	—60 85	72.96	326.13	445.65
Per cent. of ration digested	------	54.58	37 37	62.88	62.88	82.36	53.49	47.18
Per cent. of cotton-seed hulls digested	-----	43.85	46.05	−64.02	—64.02	74.26	49.77	47.24
Mean per cent. of ration digested	------	55.06	38.29	64 02	64.02	84.20	54.82	46.20
Mean per cent of cotton-seed hulls digested	----	45 06	47.64	—43.48	—43.48	78.36	51.83	46.18

Mean nutritive ratio of above rations, 1:3.77.

*One ounce, 28.35 grams

†This waste was assumed in calculating the digestibility of the hulls in the ration to be all hulls.

2. DIGESTION OF RATION OF 1 1-2 POUNDS COTTON-SEED HULLS TO 1 POUND OF MEAL.

By Steers Nos. 3 and 4.

Date of experiment, January 9 to May 24, 1894. Total period in which the ration was fed, 142⅗ days. Collection period, 8 days—4 days in each of the two weeks beginning with the 98th day of the feeding experiment.

Daily Rations Eaten. { Steer No. 3, 14.1 pounds of cotton-seed hulls and 9 59 pounds of cotton-seed meal. Steer No. 4, 12.41 pounds of cotton-seed hulls and 8.26 pounds of cotton-seed meal.

Analytical and other data for obtaining the coefficients of digestibility are presented in tables XIII. and XIV.

TABLE XIII.—Showing Percentage Composition of Cotton-seed Hulls and Meal, Waste, and Solid Excrement.

			DRY MATTER CONTAINS.					
	Water.	Dry matter.	Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fats (Ether extract.)	N-free extract.	Crude fiber.
Cotton-seed meal	8.32	91.68	6.96	47.20	47.20	10.27	28.84	6.73
Cotton-seed hulls	11.71	88.29	2.79	6.16	6.16	5.45	35.56	50.04
Waste, cotton-seed meal Steer No. 3	11.83	88.17	9.65	44.28	44.28	11.04	28.18	6.85
Solid excrement, Steer No. 3...............	77.81	22.19	6.32	18.55	18.55	1.45	32.79	40.89
Solid excrement, Steer No. 4...............	76.79	23 21	7.10	17.69	17.69	3.46	32.42	39.33

TABLE XIV.—Showing Nutrients Consumed and Excreted in Ounces, with Percentages Digested.

	Total amount.	Dry matter.	DRY MATTER CONTAINS. Ash.	Protein (N × 6.25.)	Albuminoids (Alb. N × 6.25.)	Fat, (Ether extract.)	N-free extract.	Crude fiber.
Steer No. 3. Ration: Cotton-seed hulls and meal, 1.54:1.								
Cotton-seed meal fed	1216.00	1114.83	77.59	526.20	526.20	114.49	321.52	75.03
Waste, cotton-seed meal	35.24	31.07	3.00	13.76	13.76	3.43	8.76	2.13
Cotton-seed meal consumed	1180.76	1083.76	74.59	512.44	512.44	111.06	312.76	72.90
Cotton-seed hulls fed	1824.00	1610.41	44.93	99 20	99.20	87.77	572.66	805.85
Total consumed	3004.76	2694.17	119.52	611.64	611.64	198.83	885.42	878.75
Total solid excrement	5259.20	1167 02	73.76	216.48	216 48	16.92	382.67	477.19
Total digested	......	1527.15	45.76	395.16	395.16	181.91	502.75	401.56
Digested from cotton-seed meal	......	794.40	23.50	446.34	446.34	99.62	192.35	33.83
Digested from cotton-seed hulls	......	732.75	22.26	—51.18	—51.18	82.29	310.40	367.73
Per cent of ration digested	......	56.68	38.29	64.61	64.61	91.49	56.78	49.70
Per cent. of cotton-seed hulls digested	......	45.50	49.54	—51.59	—51.59	93.76	54.20	45.63
STEER No. 4. Ration:. Cotton-seed hull sand meal, 1.5:1.								
Cotton-seed hulls fed	1728.00	1525.65	42.57	93 98	93 98	83.15	542.52	763.44
Cotton-seed meal fed	1148.16	1052.63	73.26	496.84	496.84	108.11	303.58	70.84
Total consumed	2876.16	2578.28	115.83	590.82	590.82	191.26	846.10	834.28
Total solid excrement	4955.60	1150.19	81.66	203.47	203 47	39.80	372.89	452.37
Total digested	......	1428.09	34.17	387.35	387.35	151.46	473.21	381.91
Digested from cotton-seed meal	......	771.58	23.08	432.75	432.75	96.97	186.70	32.87
Digested from cotton-seed hulls	......	656.51	11.09	—45.40	—45.40	54.49	286.51	349.04
Per cent. of ration digested	......	55.39	29.50	65.56	65.56	79.19	55.93	45.78
Per cent. of cotton-seed hulls digested	......	43.03	26.05	—48.31	—48.31	65.53	52.81	45.72
Mean per cent. of ration digested	......	56.04	33.90	65.09	65.09	85 34	56.36	47.74
Mean per cent. of cotton-seed hulls digested	......	44 27	37.80	—49.95	—49 95	79.65	53.51	45.68

Mean nutritive ratio of above rations, 1:3.18.

DOES COTTON-SEED MEAL AFFECT THE DIGESTIBILITY OF COTTON-SEED HULLS?**

Using the coefficients for cotton seed meal†† obtained by us, the digestibility of cotton-seed hulls in the various rations with meal has been calculated, and the results are presented in table XV. From this it is seen that the calculated digestibility of the hulls in the rations is greater in every case, and in some instances materially

** For similar discussion and data relating to corn silage, see N. C. Experiment Station Bulletin, 97, p. 123.
†† N. C. Experiment Station Bulletin, 97, p. 116.

TABLE XV.—Digestibility of Cotton-seed Hulls fed alone, and with different Proportions of Cotton-seed Meal.

	Total dry matter	Ash.	Protein (N × 6.25.)	Fat. (Ether extract.)	N-free extract.	Crude fiber.
Average per cent. digested from cotton-seed hulls fed alone*	39.8	19.9	6.75	85.1	36.9	43.1
Per cent. digested from cotton-seed hulls consumed with meal in proportion of 7 to 1*	40.61	35.10	—12.60	78.41	50.24	33.52
Average per cent. digested from cotton-seed hulls when fed with meal in proportion of 6 to 1 with some waste assumed to have been all hulls*	41.12	22.02	—35.71	78.02	48.00	40.08
Per cent. digested from cotton-seed hulls when fed with meal in proportion of 4 to 1 with some waste assumed to have been all hulls*	47.72	59.01	—36.02	78.93	57.11	44.95
Per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 3 to 1†	48.46	25.79	—22.27	83.04	53.60	49.79
Per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 2 8 to 1†	43.30	34 89	—22.42	75.74	48.88	43.39
Per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 2.4 to 1†	42.66	28.40	—50.49	72.79	50.77	42.93
Average per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 2 to 1†	43.12	18.77	—42.46	66.40	44.50	49.77
Average per cent. digested from cotton seed hulls when consumed with cotton-seed meal in proportion of practically 2 to 1	45.06	47.64	—43.48	78.36	51.83	46.18
Average per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 1¾ to 1	44.27	37 80	—49.95	79.65	53.51	45.68

* From Bulletin 87*d*, Tech. Bul. No. 4, pp. 31–46, N. C. Experiment Station.
† From Bulletin 97, pp. 117–122, N. C. Experiment Station.

more so, than the average of four experiments show them to have been when fed alone. There has been a decided retardation in the digestibility of protein in every case, due to the combinations. It is as though no protein has been digested from the hulls, while they have caused a decreased digestibility of the protein of the meal by the amounts indicated in the table expressed in per cent. of the protein fed in the hulls. "But the loss in protein is more than counterbalanced by the increased digestibility of carbohydrates. The gains in nitrogen-free extract and crude fiber were sufficient to increase, after bringing up the loss from protein, the digestible dry matter from .81 per cent. in the 7 to 1 ration to 8.66 per cent. in the 3 to 1 ration."‡ This is quite a decided and important increase. In the light of these experiments, we cannot, therefore, answer otherwise than that cotton-seed meal does affect and increase the digestibility of cotton-seed hulls.

‡ N. C. Experiment Station Bulletin, 97, p. 122.

FERTILIZING CONSTITUENTS OF VARIOUS RATIONS OF COTTON-SEED HULLS AND MEAL RECOVERED IN MANURE OF ANIMALS.

It is often stated that the largest, and not infrequently the only profit from feeding fattening animals is in the judicious handling and use of the manure produced. Whether the profit of feeding for beef hinges on this or not, it is a consideration deserving of more attention than is usually bestowed upon it. To emphasize this, the fertilizing constituents in various rations of cotton-seed hulls and meal and the proportion of them recovered in the manure have been determined by analyzing the foods previous to feeding and of the manure (dung and urine), excreted. These were the same rations fed in digestion experiments. The dung and urine both were collected in only five experiments. The averages obtained from these have been used in calculating the obtainable manurial value of those where the dung only was collected.

In calculating the manurial value of the rations eaten and of the manure excreted, the figures adopted for nitrogen, phosphoric acid, and potash in commercial fertilizing ingredients at Seaboard by this Station for 1895 have been used, viz.: Nitrogen, 17 cents; potash, 5 cents; and phosphoric acid, 4½ cents. The details of the experiments are presented in table XVI.

The results in table XVI. are summarized in table XVII., where all the main results can be seen at a glance and easily compared. This table shows the average daily rations, the per cents. of the total fertilizing constituents of the rations excreted in the dung and urine, taken together, and in each of these, separately, the cost of the daily rations, manurial value of the rations, and the obtainable manurial value. The obtainable manurial value represents all the constituents excreted and does not take into account any loss from decomposition, drainage, or mechanical loss in handling.

An inspection of this table shows that an average of 90 per cent. of the total fertilizing constituents of the rations were excreted in the manure, corresponding to 89.8 per cent. of the fertilizing value; that 42.5 per cent. of these constituents were contained in urine, corresponding to 50.2 per cent. of the money value; while the dung contained 47.5 per cent. of the fertilizing constituents and 39.6 per cent. of the original manurial value of the rations. These figures make apparent the value of urine as a fertilizer, especially where nitrogenous rations are fed. The urine is especially rich in nitrogen and potash, while most of the phosphoric acid is contained in the solid excrement. The average value of the urine per day and animal for the five animals, where urine was collected, was 7.14 cents against 5.63

TABLEX VI.—Fertilizing Constituents in Cotton-seed Hulls, and Rations of Cotton-seed Hulls and Meal fed and Excreted in Dung and Urine during Digestion Experiments.

	Total amount.	Dry matter.	Dry Matter Contains: Nitrogen in			Phosphoric Acid (P_2O_5) in			Potash (K_2O) in			Value of Fertilizing Consiituents Excreted in dung or urine, or both, in: 1 day	30 days	Cost of Ration,[15] per day.
	Ozs.	Ozs.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	cents.	$	cents.
BELLE OF BROOKSIDE,[2] 4 days' Experiment. Ration: 13.04 pounds Cotton-seed Hulls Daily.														
Fed in cotton-seed hulls	834.33	738.80	.790	5.837	6.20	.199	1.470	.40	1.806	13.343	4.14	2.68	.80	1.95
Excreted in dung	1495.50	473.44	.968	4.583	4.86	.371	1.756	.49	1.180	5.587	1.73	1.77	.531	
Excreted in urine	231.50	...	.814	1.881	1.99	.051	.118	.03	1.638	3.792	1.16	.80	.239	
Excreted in milk	50.00	......	.579	.289										
Total excreted				6.756[1]	6.85[1]		1.874	.52		9.379	2.89	2.57	.770	
Per cent. excreted				110.78			127.48			70.29				
Per cent. excreted in urine				32.27			119.45			41.87				
Per cent. excreted in dung				78.51			8.03			28.42				
BELLE OF BROOKSIDE,[3] 4 days' Experiment. Ration: 21 pounds Cotton-seed Hulls and 3 ponnds Meal (7:1) Daily.														
Fed in cotton-seed hulls	1341.0	1190.24	.790	9.403		.199	2.369		1.806	21.496				
Fed in cotton-seed meal	192.0	178.69	6.886	12.301		2.890	5.161		2.138	3.820				
Total in foods	1536.	1368.93		21.707	23.00		7.533	2.11		25.316	7.85	8.24	2.47	5.80
Excreted in dung	2198.	754.60	1.60	12.074	12.79	.837	6.316	1.77	1.207	9.108	2.82	4.34	1.30	
Excreted in urine	590.5	....	1.23	7.200	7.63	.087	.516	.14	1.273	7.557	2.34	2.53	.76	
Excreted in milk	76.0	....	.565	.429										
Total excreted				19.703	20.42[1]		6.832	1.91		16.665	5.16	6.87	2.06	
Per cent. excreted				88.78[1]			90.69			65.82				
Per cent. excreted in urine				33.16			6.85			29.85				
Per cent. excreted in dung				55.62			83.84			35.97				

LINEBACK STEER,[4] *5 days' Experiment. Ration: 24 pounds Cotton-seed Hulls and 4 pounds* ***Meal*** *(6:1) fed Daily*[5]

Fed in cotton seed hulls	1920.00	1598.80	.707	11.304		.240	3.837		1.208	19.314				
Fed in cotton-seed meal	320.00	291.50	6.432	18.942		3.292	9.695		2.075	6.111				
Total in foods	2240.00	1893.30		30.246			13.532			25.425				
Waste, cotton-seed hulls and meal	178.75	151.00	1.069	1.614		.389	.587		1.367	2.061				
Total consumed	2061.25	1742.30		28.632	30.35		12.945	3.62		23.361	7.24	8.24	2.47	7.20
Excreted in dung	3751.00	887.10	1.597	14.165	15.01	1.083	9.607	2.69	1.214	10.769	3.34	4.21	1.26	
Per cent. excreted in dung				49.47			74.21			46.10				

YELLOW STEER,[6] *5 days' Experiment. Ration: 21 pounds Cotton-seed Hulls and 3 1-2 pounds* ***Meal*** *(6:1) fed Daily.*[5]

Fed in cotton-seed hulls	1680.00	1398.90	.707	9.893		.240	3.357		1.208	16.899				
Fed in cotton.seed meal	280.00	257.70	6.432	16.576		3.292	8.483		2.075	5.347				
Total in foods	1960.00	1656.60		26.469			11.840			22.246				
Waste, cotton-seed hulls and meal	141.60	106.40	1.065	1.133		.47	.500		1.102	1.173				
Total consumed	1818.40	1550.20		25.336	26.86		11.340	8.17		21.073	6.53	7.31	2.19	6.30
Excreted in dung	3516.00	873.70	1.752	15.307	16.23	1.212	10.589	2.96	1.399	12.223	3.79	4.60	1.38	
Per cent. excreted in dung				60.42			93.38			58.00				

YELLOW STEER, 6 days' Experiment. Ration: 18 pounds Cotton-seed Hulls and 4 1-2 pounds ***Meal*** *(4:1) fed Daily*[5]

Fed in cotton-seed hulls	1728.00	1464.30	.699	10.235		.278	4.071		1.965	28.773				
Fed in cotton-seed meal	432.00	398.70	6.567	26.183		3.391	13.520		1.853	7.388				
Total in foods	2160.00	1863.00		36.418			17.591			36.161				
Waste, cotton-seed hulls and meal	174.50	144.40	1.319	1.904		.536	.774		1.370	1.978				
Total consumed	1985.50	1718.60		34.514	36.58		16.817	5.71		34.183	10.60	8.81	2.64	6.75
Excreted in dung	3649.00	814.10	1.997	16.256	17.23	1.432	11.658	3.26	.955	7.775	2.41	3.81	1.14	
Per cent. excreted in dung				47.10			69.32			22.75				

TABLE XVI—Continued.—Fertilizing Constituents in Cotton-seed Hulls and Rations of Cotton-seed Hulls and Meal.

	Total amount.	Dry matter.	Dry Matter Contains									Value of Fertilizing Constituents Excreted in dung or urine, or both, in		Cost of Ration,[15] per day
			Nitrogen in			Phosphoric Acid (P_2O_5) in			Potash (K_2O) in			1 day	30 days	
	Ozs.	Ozs.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	cents.	$	cents.
LINEBACK STEER,[8] 6 days' Experiment. Ration: 20 pounds Cotton-seed Hulls and 5 pounds Meal (4:1) fed Daily.[5]														
Fed in cotton-seed hulls	1824.00	1545.70	.699	10.808	.....	.278	4.297	.....	1.965	30.373				
Fed in cotton-seed meal	456.00	420.80	6.567	27.632	...	3.391	14.269	.....	1.853	7.797				
Total in foods	2280.00	1966.50	..	38.440	...	..	18.566	.....	....	38.170				
Waste, cotton seed hulls and meal	126.38	105.10	1.041	1.094	.....	.649	.682	....	1.283	1.348				
Total consumed	2153.62	1861.40	...	37.346	39.59	.....	17.884	5.01	..	36.822	11.41	9.33	2.80	7.50
Excreted in dung	3687.00	848.00	1.941	16.458	17.45	1.109	9.404	2.73	1.045	8.862	2.75	3.82	1.15	
Per cent. excreted in dung	.....	...	..	44.07	.....	....	52.58	...	......	24.07				
STEER, YELLOW 2d,[9] 5 days' Experiment. Ration: 18 pounds Cotton-seed Hulls and 6 pounds Meal (3:1) Daily.														
Fed in cotton-seed hulls	1440.00	1262.20	.771	9.734	......	.251	3.168	......	1.174	14.818				
Fed in cotton-seed meal	480.00	446.30	6.773	30.227	......	2.473	11.037	...	1.715	7.654				
Total consumed	1920.00	1708.50	......	39.961	42.37	......	14.205	3.98	....	22.472	6.97	10.66	3.20	8.70
Excreted in dung	2687.50	769.70	2.026	15.590	16.53	1.599	12.308	3.45	1.305	10.045	3.11	4.64	1.39	
Per cent. excreted in dung		......	..	39.01	......	......	86.64	..	......	44.70				
LOPHORN STEER,[10] 5 days' Experiment. Ration: 21 pounds Cotton-seed Hulls and 7 1-2 pounds Meal (2.8:1) Daily.														
Fed in cotton-seed hulls	1680.00	1472.50	.771	11.353	....	.251	3.696	......	1.174	17.287				
Fed in cotton-seed meal	600.00	557.80	6.773	37.780	...	2.473	13.794	.....	1.715	9.566				
Total consumed	2280.00	2030.30	......	49.133	52.08	....	17.490	4.90	.....	26.853	8.32	13.06	3.92	9.90
Excreted in dung	4082.30	983.80	1.881	18.510	19.62	1.360	13.380	3.75	1.240	12.199	3.78	5.43	1.63	
Per cent. excreted in dung	.....	.....	.....	37.67	......	......	76.50	......	......	45.43				

LOPHORN STEER,[11] 5 days' Experiment. Ration: 20.6 pounds Cotton-seed Hulls and 8.6 pounds Meal (2.4:1) Daily.

Fed in cotton-seed hulls	1680.00	1472.50	.771	11.355	...	.251	3.696	...	1.174	17.287				
Fed in cotton-seed meal	840.00	780.90	6.773	52.888	...	2.473	19.312	...	1.715	13.392				
Total in foods fed	2520 00	2253.40	...	64.243	...	...	23.008	...	...	30.679				
Waste, cotton-seed hulls	26.50	24.10	4.647	1.120	...	1.669	.402	...	1.444	.348				
Waste, cotton-seed meal	153.10	141.10	6.378	9.200	...	2.452	3.460	...	1.730	2.441				
Total in waste	179 60	165.20	...	10.320	...	...	3.862	...	...	2.789				
Total consumed	2340.40	2088.20	...	53.923	57.16	...	19.146	5.36	...	27.890	8.65	14.23	4.27	10.83
Excreted in dung	4335 00	1001.40	2.070	20.733	21.98	1.632	16.343	4.58	1.106	11.075	3.43	6.00	1.80	
Per cent. excreted in dung	...	...	...	38.45	...	...	85.36	...	...	39.17				

STEER, YELLOW 2d,[12] 1st Experiment of 5 days. Ration: 18 pounds Cotton-seed Hulls and 8.9 pounds Meal (2.02:1) Daily.

Fed in cotton-seed hulls	1440.00	1262.20	.771	9.732	...	.251	3.168	...	1.174	14.818				
Fed in cotton-seed meal	720.00	669.40	6.773	45.338	...	2 473	16.554	...	1.715	11.480				
Total in foods	2160.00	1931.60	...	55.070	...	...	19.722	...	...	26.298				
Waste, cotton seed meal	7.40	6.80	7.059	.480	...	2.599	.177	...	1.682	.114				
Total consumed	2152.60	1924.80	...	54.590	57.87	...	19 545	5.47	...	26.184	8.12	14.29	4.29	10.71
Excreted in dung	3244.00	926 50	2.170	20 101	21.31	2.064	19.123	5 35	1.134	10.507	3.26	5.98	1.79	
Per cent. excreted in dung	...	...	...	36 82	...	...	97.84	...	...	40.13				

STEER, YELLOW 2d,[13] 2d Experiment of 5 days. Ration: 18 pounds Cotton-seed Hulls and 9 pounds Meal (2:1) Daily,

Fed in cotton-seed hulls	1440.00	1262.20	.771	9.732	...	.251	3.168	...	1.174	14.818				
Fed in cotton-seed meal	720.00	669.40	6.773	45.338	...	2.473	16.554	...	1.715	11.480				
Total consumed	2160.00	1931.60	...	55.070	58.37	...	19.722	5.52	...	26.298	8.15	14.41	4.32	10.80
Excreted in dung	3114.20	864.80	2.155	18.638	19.76	1.943	16.803	4.70	1.015	8.778	2.72	5.44	1.63	
Per cent. excreted in dung	...	...	...	33 48	...	...	85.20	...	...	33.38				

TABLE XVI—Concluded.—Fertilizing Constituents in Cotton-seed Hulls and Rations of Cotton-seed Hulls and Meal.

	Total amount.	Dry matter.	Dry Matter Contains: Nitrogen in			Phosphoric Acid (P_2O_5) in			Potash (K_2O) in			Value of Fertilizing Constituents Excreted in dung or urine, or both, in 1 day	30 days	Cost of Ration,[15] per day.
	Ozs.	Ozs.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	Per cent.	Ozs.	Val., cents.	cents.	$	cents.
STEER No. 1, 8 days' Experiment. Ration: 18 pounds Cotton-seed Hulls and 9 pounds Meal (2:1) Daily.														
Fed in cotton-seed hulls	2281.18	2014.05	.986	19.851	.....	.404	8.137	.....	1.095	22.054				
Fed in cotton-seed meal	1146.36	1050.98	7.552	79.370	.....	3.076	32.328	.....	1.947	20.463				
Total consumed	3427.54	3065.03	.....	99.221	105.17	.....	40.465	11.33	.....	42.517	13.18	16.21	4.86	10.80
Excreted in dung	6384.00	1362.98	2.536	34.565	36.64	1.976	26.932	7.54	1.010	13.766	4.27	6.06	1.82	
Excreted in urine	2489.12	.....	2.04	50.778	53.82	.255	6.347	1.78	1.072	26.683	8.27	7.98	2.39	
Total excreted	.....	.....	.....	85.343	90.46	.....	33.279	9.32	.....	40.449	12.54	14.04	4.21	
Per cent. excreted	.....	.....	.....	86.01	.....	.....	82.24	.....	.....	95.14				
Per cent. excreted in urine	.....	.....	.....	51.18	.....	.....	15.69	.....	.....	62.76				
Per cent. excreted in dung	.....	.....	.....	34.84	.....	.....	66.56	.....	.....	32.38				
STEER No. 2, 8 days' Experiment. Ration: 16 1-4 pounds Cotton-seed Hulls and 8.99 pounds Meal (1.81:1) Daily.														
Fed in cotton-seed hulls	2304.00	2034.20	.986	20.050	.....	.404	8.218	.....	1.095	22.274				
Waste, cotton-seed hulls and meal[14]	223.00	192.47	2.516	4.842	.....	.956	1.840	.....	1.351	2.600				
Cotton-seed hulls consumed	2081.00	1841.73	.....	15.208	.....	.....	6.378	.....	.....	19.674				
Fed in cotton-seed meal	1150.72	1051.98	7.552	79.672	.....	3.076	32.451	.....	1.947	20.540				
Total consumed	3231.72	2896.71	.....	94.880	100.57	.....	38.829	10.87	.....	40.214	12.47	15.49	4.65	10.53
Excreted in dung	5148.00	1315.83	2.677	35.222	37.34	1.889	24.856	6.96	1.059	13.935	4.32	6.08	1.82	
Excreted in urine	3440.32	.....	1.60	55.045	58.35	.29	9.977	2.79	.753	25.906	8.03	8.64	2.60	
Total excreted	.....	.....	.....	90.267	95.69	.....	34.833	9.75	.....	39.841	12.35	14.72	4.42	
Per cent. excreted	.....	.....	.....	95.14	.....	.....	89.71	.....	.....	99.07				
Per cent. excreted in urine	.....		.....	58.02	.....	.....	25.69	.....	.....	64.42				
Per cent. excreted in dung	.....		.....	37.12	.....	.....	64.01	.....	.....	34.65				

STEER No. 3, 8 days' Experiment. Ration: 14 1-4 pounds Cotton-seed Hulls and 9.22 pounds Meal (1.54:1) Daily.

Fed in cotton-seed meal	1216.00	1114.83	7.552	84.192	.....	3.076	34.292	.....	1.947	21.706				
Waste, cotton-seed meal	35.24	31.07	7.087	2.202	....	2.842	.883	.....	2.112	.656				
Cotton-seed meal consumed	1180.76	1083.76	.....	81.990	.....	.....	33.409	.....	.	21.050				
Fed in cotton-seed hulls	1824.00	1610.41	.986	15.879	....	.404	6.506	.....	1.095	17.634				
Total consumed	3004.76	2694.17	.....	97.869	103.74	...	39.915	11.18	.....	38.684	11.99	15.86	4.76	10.44
Excreted in dung	5259.20	1167.02	2.968	34.637	36.72	1.758	20.516	5.74	.840	9.803	3.04	5.68	1.70	
Excreted in urine	3220.00	..	1.67	53.774	57.00	.445	14.329	4.01	.941	30.300	9.39	8.80	2.64	
Total excreted	...	.....	.....	88.411	93.72	.....	34.845	9.75	.....	40.103	12.43	14.48	4.34	
Per cent. excreted	.....	.....	.....	90.34	....	.....	87.30	.....	.....	103.67				
Per cent. excreted in urine	.....	.....	.....	54.95	.....	.....	35.90	.....	...	78.33				
Per cent. excreted in dung	.....	.....	.....	35.39	.....		51.40	.....	.....	25.34				

STEER No. 4, 8 days' Experiment. Ration: 13 1-2 pounds Cotton-seed Hulls and 8.97 pounds Meal (1.5:1) Daily.

Fed in cotton-seed hulls	1728.00	1525.65	.986	15.043	.....	.404	6.164	.....	1.095	16.706				
Fed in cotton-seed meal	1148.16	1052.63	7.552	79.495	.....	3.076	32.379	.....	1.947	20.495				
Total consumed	2876.16	2578.28	.....	94.538	100.21	...	38.543	10.79	.....	37.201	11.53	15.32	4.60	10.09
Excreted in dung	4955.60	1150.19	2.830	32.555	34.51	2.736	31.469	8.81	1.297	14.918	4.62	5.99	1.80	
Excreted in urine	2515.2	...	2.04	51.310	54.39	.13	3.270	.92	.859	21.606	6.70	7.75	2.32	
Total excreted	.....	.....	.....	83.865	88.90	.....	34.739	9.73	.....	36.524	11.32	13.74	4.12	
Per cent. excreted	.....	.....	.....	88.71	.....	.....	90.13	.....	.....	98.18				
Per cent. excreted in urine	.....	.....	.....	54.27	.....	. .	8.49	.....	.....	58.08				
Per cent. excreted in dung	.....	.....	.....	34.44	.....	.....	81.65	...	.....	40.10				
Mean per cent. excreted,[16]	.....	.....	.....	89.8	.....	.....	88.0	.....	.....	92.4				
Mean per cent. excreted in urine,[16]	.....	.....	.....	50.3	.....	.....	18.5	.....	.....	58.7				
Mean per cent. excreted in dung,[16]	...	.....	.....	39.5	....	.....	69.5	.....	.....	35.7				

[1]Total excreted in dung and urine only. [2]From N. C. Station Bulletin 80*c*, p. 11. [3]Ibid., p. 12. [4]From Bulletin 87*d*, p. 41. [5]All these rations were not eaten. [6]Ibid., p. 40. [7]Ibid., p. 45. [8]Ibid., p. 44. [9]N. C. Station Bulletin 97, p. 118. [10]Ibid., p. 119. [11]Ibid., p. 120. [12]Ibid., p. 121. [13]Ibid., p. 121. [14]This waste was assumed to be all hulls, whereas it contained a small amount of meal mixed with it. [15]The cost of rations is calculated on basis of cotton-seed hulls at $3.00 per ton and meal at $18.00. [16]Not including Belle of Brookside on ration of hulls alone.

TABLE XVII.—Data Relating to the Fertilizing Constituents of Rations of Cotton-seed Hulls and Meal.

	Daily ration in lbs.		Per cent. of fertilizing constituents in rations excreted in—											
			Dung and urine.			Urine.			Dung.					
	Cotton seed hulls.	Cotton-seed meal.	Nitrogen.	Phosphoric Acid (P_2O_5).	Potash (K_2O).	Nitrogen.	Phosphoric Acid (P_2O_5).	Potash (K_2O).	Nitrogen.	Phosphoric Acid (P_2O_5).	Potash (K_2O).	Total cost of daily ration.[3]	Manurial value of daily ration.	Obtained manurial value of daily ration.
												Cts.	Cts.	Cts.
Steer No. 4	13.5	8.97	88.7	90.1	98.2	54.3	8.5	58.1	34.4	81.7	40.1	10.09	15.32	13.74
Steer No. 3	14.3	9.22	90.3	87.3	103.7	55.0	35.9	78.3	35.4	51.4	25.3	10.44	15.86	14.48
Steer No. 2	16.3	8.99	95.1	89.7	99.1	58.0	25.7	64.4	37.1	64.0	34.7	10.53	15.49	14.72
Steer No. 1	18.0	9.00	86.0	82.2	95.1	51.2	15.7	62.8	34.8	66.6	32.4	10.80	16.21	14.04
Belle of Brookside	21.0	3.00	88.8	90.7	65.8	33.2	6.9	29.9	55.6	83.8	36.0	5.80	8.24	6.87[2]
Mean of 5 experiments	....	..	89.8	88.0	92.4	50.3	18.5	58.7	39.5	69.5	33.7	9.53	14.22	12.77
				90.0			42.5			47.5				
Steer, Yellow 2d, 2d experiment	18.0	9.00	....	....	.....	....	....	....	33.8	85.2	33.4	10.80	14.41	12.97[1]
Steer, Yellow 2d, 1st experiment	18.0	8.90	....	....	.....	....	....	....	36.8	97.8	40.1	10.71	14.29	12.86[1]
Lophorn steer	20.6	8.60	....	....	.....	....	....	....	38.5	85.4	39.2	10.83	14.23	12.81[1]
Lophorn steer	21.0	7.50	....	....	.....	....	....	....	37.7	76.5	45.4	9.90	13.02	11.72[1]
St'r, Yellow 2d	18.0	6.00	....	....	.....	....	....	....	39.0	86.6	44.7	8.10	10.66	9.59[1]
Lineback steer	20.0	5.00	....	....	.....	....	....	....	44.1	52.6	24.1	7.50		
Yellow steer	18.0	4.50	....	....	.....	....	....	....	47.1	69.3	22.8	6.75		
Yellow steer	21.0	3.50	....	....	.....	....	....	....	60.4	93.4	58.0	6.30		
Lineback steer	24.0	4.00	....	....	.....	....	....	....	49.5	74.2	46.1	7.20		
Mean of 14 experiments	....	....	....	....	.....	....	....	....	41.7	76.3	37.3			

[1] Calculated by using the results of the first five experiments.
[2] This cow was giving about one pint of milk per day.
[3] Cost of rations on basis of cotton-seed hulls at \$3.00 and meal at \$18.00 per ton.

cents for the solid excrement for the same time and animals. It will also be seen from this table that the value of the manure from animals depends on the food given. Cotton-seed hulls are poor in fertilizing constituents, while cotton-seed meal is very rich in them. The value of the manure, therefore, rises and falls with the proportion of hulls and meal in the ration.

There is one specially noticeable and important feature connected with these rations of hulls and meal from a manurial standpoint.

The obtainable manurial value of the rations is in all cases materially greater than the original cost of the foods making the rations. The average cost of the daily rations of the five animals, whose dung and urine were both collected and analyzed, was 9.53 cents, valuing cotton-seed meal at $18.00 and cotton-seed hulls at $3.00 per ton. The average total manurial value of the same rations was 14.22 cents, and the obtainable manurial value 12.77 cents. The obtainable manurial value of the rations (12.77 cents) is 134 per cent. of the original cost of the rations (9.53 cents). It is as though the growth and fattening of the animals was obtained for nothing, and there was still a balance of 34 per cent. of the original cost of the rations in the manure pile to the credit of the feeder. These results would not be obtained in ordinary practice since no account is taken of the unavoidable loss in handling and resulting from decomposition. Neither do these figures take into account the cost of feeding and applying the manure to the land.

Volumetric Estimation of Phosphoric Acid

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THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

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RALEIGH, N. C.

VOLUMETRIC ESTIMATION OF PHOSPHORIC ACID

INCLUDING

I. THE ESTIMATION OF PHOSPHORIC ACID BY TITRATION OF THE YELLOW PRECIPITATE OF AMMONIUM PHOSPHO-MOLYBDATE, BY B. W. KILGORE.

II. THE ESTIMATION OF PHOSPHORIC ACID IN SOILS BY DOUBLE PRECIPITATION WITH MOLYBDIC SOLUTION, AND TITRATION OF THE AMMONIUM PHOSPHO-MOLYBDATE WITH STANDARD ALKALI, BY C. B. WILLIAMS.

I. THE ESTIMATION OF PHOSPHORIC ACID BY TITRATION OF THE YELLOW PRECIPITATE OF AMMONIUM PHOSPHO-MOLYBDATE.

BY B. W. KILGORE, ASSISTANT CHEMIST.

Methods based upon this principle, but varying in manipulation, have been described by a number of chemists, especially for the estimation of small quantities of phosphorus. C. E. Manby[1], J. O. Handy[2], M. Rothberg and W. A. Auchinvole[3] have used this principle in working out somewhat different methods for the estimation of phosphorus in iron and steel and their ores, and E. Thilo[4], made the same principle the basis of a process for determining phosphoric acid in Thomas Slag.

Dr. Franz Hundeshagen[5], in his analytical studies of ammonium phospho-molybdate, shows its composition under all conditions, when free from molybdic acid and other impurities, to be $12MoO_3.PO_4.3NH_4$, and describes a method for estimating phosphoric acid by titrating the ammonium phospho-molybdate precipitate with alkali, but gives no results to show the accuracy or practicability of his method.

On this same principle, H. Pemberton[6], Jr., has worked out a method, which he has applied to the determination of phosphoric acid in high and low-grade phosphates. He makes the solution of his phosphate in nitric acid, takes a portion of the solution corresponding to 0.1 gram substance for analysis, precipitates at boiling temperature with aqueous ammonium molybdate, adding successive 5 cc. portions of the molybdic solution at a time until precipitation

[1]Jour. Anal. Appl. Chem. **6**, 82; [2]Ibid. **6**, 204; [3]Ibid. **6**. 243; [4]Jour. Anal. Chem. **1**, part 2, 219; [5]Zeitschrift f. Analytische Chemie. **28**, 141–172.
[6]Jour. Am. Chem. Soc., **15**, 382.

is complete, filters, washes with water, titrates with potassium hydroxid, free from carbonates, and back with hydrochloric acid.

The writer investigated this method in the fall of 1893, in the laboratory of this Station, and tried it upon quite a number of phosphates and fertilizer materials of varying percentages of phosphoric acid. The results were fairly good generally, but were subject to very wide variations at times, the tendency of the method being to give high results, although liberal amounts of water were used to remove free acid. Often one thousand or more cc. of water were used for washing. It was believed that molybdic acid was the cause of the variations, as it was known that molybdic acid would deposit from other molybdic solutions very quickly at the temperature of precipitation used in the Pemberton method. To see if the aqueous molybdate was an exception to this rule, and also to see if the official molybdate of the Association of Official Agricultural Chemists would take the place of the aqueous solution, the official molybdate was used for precipitating at boiling temperature, the method as described by Pemberton being carried out otherwise, except that 0.2 to 0.4 gram of substance was used for analysis.

Results obtained in this way were less subject to variations than when the aqueous molybdate was employed, though high percentages would still often be obtained. Both molybdates were now tried side by side in the water-bath at temperatures of 70°, 65°, and 60° C., allowing five minutes for precipitation, which was found in all cases to be complete. The results thus obtained were favorable to the lower temperature of 60° C. in bath, and to the official molybdate, there being very few variations from the gravimetric method when precipitation was made at 60° C. and with the official molybdic solution. A great many results were obtained in testing these and other points, but most of the early ones were not kept.

In the following table (I) are brought together some of the earlier results and all of the later ones by the volumetric method, either as carried out by Pemberton or myself, or both, in the order in which they were obtained, and also results by the gravimetric method on the same samples for comparison. The gravimetric results were not duplicated. Among the earlier results by the volumetric method, there are quite a number of wide variations from gravimetric results, but the later ones by the volumetric method, as carried out by myself, nearly all show close agreement with gravimetric results.

Thus far, there are two main differences in the volumetric method as carried out by Pemberton, and as carried out by myself. First, the temperature of precipitation in the former is at boiling; in the latter 60° C. At the former temperature molybdic acid deposits very quickly, especially if any considerable excess of the precipitant be present. If we know how much phosphoric acid our samples contain and add just enough molybdate to accomplish the result, or are willing to add little by little of the precipitating reagent until the proper amount has been added, this objection is largely overcome; but the former we do not know, and the latter is tedious and

TABLE I.—Determinations of Phosphoric Acid in Various Fertilizers by the Gravimetric Method, and by the Volumetric Method as Carried out by Pemberton, and as Carried out by Kilgore.

No. of Sample.	Official Method.	Pemberton Method.	Kilgore Method.	No. of Sample.	Official Method.	Pemberton Method.	Kilgore Method.
1	10.40	......	10.34[1]	48	15.75	......	15.50[2]
2	9.48	......	9.40[1]	49	8.14	......	8.40[2]
2	......	......	10.52[1]	50	8.40	......	8.22[2]
3	2.44	......	2.53[1]	51	10.73	......	10.80[2]
4	2.85	......	2.78[1]	52	9.63	......	9.67[2]
5	3.90	......	3.83[1]	53	10.50	......	10.48[2]
5	......	......	3.80[1]	54	10.53	......	10.58[2]
6	.08	......	.30[1]	55	11.13	......	11.10[4]
7	2.17	2.18	......	56	8.96	......	8.87[4]
8	2.72	......	2.62[1]	57	10.75	......	10.72[4]
9	3.76	3.76	......	58	10.73	......	10.74[4]
10	15.58	......	15.48[1]	59	11.63	......	11.53[4]
10	......	......	15.40[1]	60	9.59	......	9.64[3]
11	14.09	......	13.96[2]	61	13.96	......	14.18[3]
12	13.61	......	13.36[2]	62	14.43	......	14.33[6]
12	......	......	13.60[2]	63	14.37	......	14.23[6]
13	12.98	......	13.06[1]	64	10.67	......	10.65[3]
14	9.79	10.60	9.63[2]	65	9.49	......	9.55[3]
14	......	......	9.70[2]	66	10.61	......	10.77[3]
15	9.95	10.25	9.90[2]	67	10.93	......	11.11[3]
15	......	10.20	9.83[2]	68	11.55	......	11.59[6]
16	1.25	......	1.14[2]	69	12.60	......	12.45[6]
17	2.64	......	2.56[2]	70	10.16	......	10.45[6]
18	1.68	......	1.58[2]	71	14.80	......	14.77[6]
19	4.06	4.05	......	72	9.95	......	10.20[2]
20	2.07	2.10	......	73	9.93	......	10.22[2]
21	1.37	1.31[2]	......	74	9.63	......	9.80[2]
22	2.14	2.19[2]	......	75	10.52	......	10.49[7]
23	1.30	......	1.23[2]	76	11.00	......	10.98[2]
24	3.93	......	3.93[2]	77	10.68	......	10.71[7]
25	10.90	10.87	......	78	13.43	......	13.26[7]
26	11.28	11.90[2]	......	79	12.63	......	12.60[7]
27	8.89	10.55	9.00[2]	80	15.06	......	14.89[7]
28	10.61	10.98	......	81	14.79	......	14.84[7]
29	9.93	10.14	......	82	14.87	......	14.84[7]
30	9.72	9.98	......	83	12.22	......	12.17[7]
31	10.59	10.96	......	84	12.75	......	12.72[2]
32	9.04	......	9.10[3]	85	12.46	......	12.34[7]
33	8.72	......	8.72[3]	86	11.23	......	11.09[7]
34	10.07	......	10.00[4]	87	9.03	......	9.12[7]
35	10.41	......	10.26[4]	88	10.49	......	10.40[7]
36	10.43	......	9.46[5]	89	15.43	......	15.30[7]
37	12.26	......	9.94[5]	90	16.27	......	15.86[7]
38	8.83	......	8.84[3]	91	15.98	......	15.61[7]
39	8.11	......	8.08[4]	92	15.71	......	15.71[7]
40	13.36	......	8.87[5]	93	11.83	......	11.63[7]
41	10.59	......	10.34[3]	94	10.04	......	9.94[7]
42	8.83	......	8.56[4]	95	13.28	......	13.25[7]
43	9.17	......	9.26[3]	96	10.55	......	10.42[7]
44	9.12	......	9.17[2]	97	10.41	......	10.40[7]
45	10.20	......	10.33[2]	98	9.76	......	9.62[7]
46	13.70	......	13.62[3]	99	11.26	......	11.25[3]
47	13.92	......	13.92[3]	100	11.49	......	11.37[7]

TABLE I.—Concluded—Determinations of Phosphoric Acid in Various Fertilizers, etc.

No. of Sample	Official Method.	Pemberton Method.	Kilgore Method.
101	15.83	....	15.73[7]
102	15.71	....	15.71[7]
103	15.25	....	15.20[7]
104	11.64	12.15	11.63[2]
105	15.89	16.20	15.71[2]
106	15.54	16.15	15.65[7]
107	15.20	16.17	15.25[2]
108	13.96	....	14.18[7]
109	13.60	....	13.67[7]
110	15.67	....	15.82[7]
111	11.80	....	11.85[7]
112	11.74	....	11.75[7]
113[8]	19.93	20.35	19.85[7]
	19.83	20.15	19.95[7]
	19.91	20.15	19.90[7]
	19.85	20.10	19.80[7]

No. of Sample.	Official Method.	Pemberton Method.	Kilgore Method.
114	17.17	17.20	17.15[7]
	17.12	17.40	17.10[7]
115	2.42	....	2.47

(1) Precipitated at boiling.
(2) Precipitated in bath at 70° C.
(3) Precipitated in bath at 65° C.
(4) Precipitated in bath at 65° C. with the addition of 5 cc. HNO_3 to 50 cc. molybdic solution (official).
(5) Same as (4) with 10cc HNO_3.
(6) Same as (4) with 3cc HNO_3.
(7) Precipitated in bath at 60° C.
(8) C. p. $Na_2HPO_4 . 12H_2O$, =19.826 per cent. P_2O_5.

time-consuming, especially where large numbers of analyses are being carried on at once. At 60° C. the official molybdate does not deposit generally, any appreciable amount of molybdic acid for fifteen minutes or more; precipitation is always complete in five or six minutes from the time the molybdate is added, and filtration of six to a dozen precipitates can be finished in four or five minutes more. This procedure then seems to possess the advantages of less danger of molybdic acid depositing, and also of being able to handle it a larger number of determinations at once.

The second difference is in the two molybdic solutions. The official molybdic solution contains practically 60 grams MoO_3 to the liter, and the Pemberton solution, 66 grams to the liter. So, there is no very great difference in their precipitating powers. In the official molybdate the proportion of free nitric acid to molybdic acid is always the same, being equivalent to nearly 15 cc. of 1.42 sp. gr. nitric acid to 50 cc. of molybdic solution, while in Pemberton's molybdate, the quantity is just 5 cc. of 1.42 sp. gr. nitric acid, no matter whether 25 cc. or 50 cc. of the aqueous molybdate is added. It will be readily understood that, should any considerable excess of this aqueous molybdate be added (and such a thing is liable to be done), and there being only 5 cc. of nitric acid to hold it in solution, precipitation of molybdic acid would be sure and quick. Experiments were made with varying quantities of these two molybdates to see which was most liable to deposit molybdic acid under the same conditions, the conditions being as nearly as possible those of precipitation without the presence of the phosphate[1]. In these experiments, amounts of the two solutions necessary for precipita-

[1] For details of these experiments, see Jour. Am. Chem. Soc. 16, 765.

ting high, low, and medium percentages of phosphoric acid were used, the same quantity of MoO_3 being present in the parallel expements. The results showed that the aqueous molybdate deposits far more readily and heavily than did the official nitric acid molybdic solution in the same time and under the same conditions; and the results further argued that the official molybdate contains sufficient nitric acid to prevent quick deposit of molybdic acid (quicker than 15 minutes or more) and at the same time not enough to interfere with quick precipitation of phosphoric acid.

The aqueous molybdate, as used by Pemberton, works well when added just in the proper quantities, but there is not enough free nitric acid present to allow of much marginal excess. The official molybdate seems to contain a very large amount of free nitric acid. To test the effect of still larger quantities of free acid, the results in table I, as designated by the foot-notes, show that 10 cc. additional nitric acid of 1.42 sp. gr. to 50 cc. molybdate hindered precipitation greatly; 5 cc. prevented its being complete in five minutes, while 3 cc. additional did not seem to interfere. The more free nitric acid present, not to interfere with precipitation, the less liability there is of molybdic acid depositing. Just here should be said that the deposit from the official molybdic solution is not molybdic acid alone, but a mixture of molybdic acid and ammonium molybdate. One deposit was found to contain 1.21 per cent. ammonia[1].

The writer was the reporter of the Association of Official Agricultural Chemists on phosphoric acid for the year 1893–'94, and the foregoing investigation of the volumetric method was, in part, undertaken to see if it was sufficiently accurate and trustworthy, or if it could be developed into a sufficiently reliable method to be used by these chemists in their official work. The present official gravimetric method is rather long and often gives quite varying results in the hands of different analysts. These objections to the molybdate method, together with the immense volume of phosphoric acid work which has to be done in connection with Fertilizer Control Stations and fertilizer factories, makes it doubly important that a quick and accurate method for phosphoric acid estimation should, if possible, be found.

The volumetric method seemed to promise well, and it was accordingly recommended, both as originally described by Pemberton and as modified by the writer, to various official and other chemists interested in phosphoric acid work for trial. Three phosphate samples were prepared upon which to conduct the investigations.

No. 1 was a mixture of cotton-seed meal and castor pomace, containing about 2.50 per cent. P_2O_5.

No. 2 was an acid phosphate, containing about 17 per cent. P_2O_5.

No. 3 was a solution of c. p. di-sodium hydrogen phosphate ($Na_2HPO_4.12H_2O$), containing 19.826 per cent. P_2O_5.

[1] The foregoing is condensed and partly re-written from a paper read before the A. A. O. C. in August, 1894, and published in Bul. 43, Div. Chem, U. S. Dept. Agr., p. 100, and Jour. Am. Chem. Soc., 16, 765.

The results obtained in this laboratory[1] on these samples by the different methods and presented to the Association, are shown in table II.

These results, with a few exceptions, indicate well for the volumetric method, especially the method as described by the writer, there being only one result (20.10 per cent. on sample No. 3) by this method without a reasonable error of analysis. The larger percentage of the results, however, on samples 2 and 3 by the method as carried out by Pemberton, are high.

The corresponding results on these samples by some 16 other chemists were not, as a whole, nearly so encouraging as those presented above, which was likely due to the greater familiarity with the volumetric methods in this laboratory. Then, too, the very large volume of wash water (amounting in some cases to more than 1000 cc.), found necessary by a great many to remove free acid from the precipitate, made the washing tedious and gave the method in most hands little or no advantage, as regards time, over the gravimetric method, and no advantage in point of accuracy, the latter being especially true when it is made known that, now and then, unaccountably high results in the midst of good ones would be obtained by many analysts.

Notwithstanding these difficulties, most of the chemists who had tried the volumetric method, in the different forms in which it was employed up to this time, considered the results as encouraging, but not such as to give them any considerable faith in the method, especially for high percentages.

At this point, the writer again commenced to study further the volumetric method in its various phases, and to try numerous modifications of it. The results obtained and presented in table I, by the writer's modification of the Pemberton method, consisting in a different molybdic solution and temperature of precipitation, are much more uniform and satisfactory than those obtained by the original Pemberton method on the same samples. This modified method gave quite as good results in the writer's hands as did the official method. It was, therefore, decided to use this modified procedure: that is, precipitation at 60° C. and with the official molybdic solution as the starting point for the investigation.

Knowing that the deposition of molybdic acid was the cause of the trouble in the volumetric method, various ways of getting rid of it were tried. One attempt was to dissolve the ammonium phospho-molybdate in the least possible quantity of concentrated ammonia, thus changing any molybdic acid to ammonium molybdate, acidifying with nitric acid, evaporating to dryness, and heating to drive off nitric acid. This was not practicable, for other reasons than that molybdic acid was again formed from the ammonium molybdate on heating to a temperature that would drive off nitric acid. Distillation of the ammonia from the "yellow precipitate,"

[1] The results of other chemists on these samples will be found in Bul. 43, Div. Chem. U. S. Dept. Agr., p. 81.

TABLE II.—Total Phosphoric Acid in above Samples 1, 2, and 3.

Analyst.	Sample No. 3.					Sample No. 2.					Sample No. 1.				
	Methods and washing.					Methods and washing.					Methods and washing.				
	Official gravimetric.	Volumetric as carried out by Pemberton.	Washings.	Volumetric as carried out by Kilgore.	Washings.	Official gravimetric	Volumetric as carried out by Pemberton.	Washings.	Volumetric as carried out by Kilgore.	Washings.	Official gravimetric	Volumetric as carried out by Pemberton.	Washings.	Volumetric as carried out by Kilgore.	Washings.
	Per ct.	Per ct.	cc.	Per ct.	cc.	Per ct.	Per ct.	cc.	Per ct.	cc.	Per ct.	Per ct	cc.	Per ct.	cc.
W. M. Allen						17.13			17.15	650 to 800	2.52			2 50	350 to 400
						17.18			17 00		2.52			2.55	
						17.15			17.10					2 55	
F. B. Carpenter	[3]19 93	20.00		19 85											
	[3]19.94	20.15		20.10		17.04	17.10		17.15		2.65	2.58		2.55	
	19 93					17.12	17.15		17.15		2.61	2.63		2.58	
	19.91					17 10									
B. W. Kilgore	20 06	20.35	650	19.85		17.17	17.20	500	17 15	450	2.42			2.50	250
	19.93	20.15	850	19.95	650	17.12	17 40	500	17.10	450				2.45	250
	[4]19.83	20.15	850	19.90	850	[1]16 98			16 97	450					
	[4]19.83	20.10	1,000	19.90	800	[1]16 98			17.00	500					
	[3]19 91			19 80	1,000				17.10	500					
	[3]19.85														
C. B. Williams	[3]20.03								17.10	500				2.50	500
	[3]20.05					[4]16.96			17.10	500				2.50	

[1] The "white" precipitate was dissolved and reprecipitated. [3] Precipitated with magnesia mixture direct. [4] One gram citric acid added before precipitating with magnesia mixture.

and the calculation of the phosphoric acid from it, would not answer, as the deposit of molybdic acid carries ammonium molybdate with it. Finally, it was determined to try to find wash solutions, which would dissolve molybdic acid but not ammonium phospho-molybdate.

Using a c. p. di-sodium hydrogen phosphate containing 19.826 per cent. P_2O_5, the following results (table III) were obtained with different strengths of nitric acid for washing, finishing with potassium nitrate solution and water to remove nitric acid.

TABLE III.—Tests with Various Wash Solutions.

Number of times washed with water by decantation.	Number of times washed with dilute nitric acid by decantation.	Number of times washed with 3 per cent. potassium nitrate by decantation.	Washed on filter with water, cc.	5 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	10 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	20 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	Washed with water only.
				Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
....	1	2	275	....	....	19.80	....
1	1	1	275	....	19.84	....	....
2	1	....	275	19.98	....	....	....
....	2	1	400	....	....	19.80	....
....	2	1	400	....	19.87	....	....
1	2	....	275	19.80	....	....	....
3	....	....	400	....	....	....	19.98
....	2	1	230	....	19.87	....	....
....	2	1	350	....	19.83	....	....
3	....	....	700	....	....	....	19.93
3	....	....	550	....	....	....	19.87

The washing with dilute nitric acid and 3 per cent. potassium nitrate solution was always by decantation, using 50 cc. to 75 cc., agitating thoroughly, and allowing the precipitate to settle completely each time. When the washing was with water alone, the results are high, while washing twice by decantation with 10 cc. 1.42 sp. gr. nitric acid in 100 cc. water, once by decantation with 3 per cent. potassium nitrate solution, and then with about 300 cc. water on the filter, the results are close to theoretical ones.

Solubility of Molybdic Acid in Various Wash Solutions.—It now seemed important to investigate the solubility of molybdic acid in various solutions which might be used for washing. The results of this work is contained in the table below (IV) and the solubility is expressed in terms of the number of cc. of the standard volumetric alkali neutralized by the molybdic acid dissolved. 100 cc. of this alkali equals 32.38 cc. normal alkali.

These solubility determinations were made by allowing 100 cc. of the respective solutions to stand in a beaker with the molybdic acid for the times indicated in the table, stirring once or twice to keep the molybdic acid in contact with the liquid, but allowing sufficient

TABLE IV.—Solubility of Molybdic Acid in Various Wash Solutions.

No. of solution.	Amount of MoO_3.	Amount of solutions, in cc.	Time of standing, hours	Water.	2 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	5 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	10 cc. 1.42 sp. gr. nitric acid in 100 cc. water	20 cc. 1.42 sp. gr. nitric acid in 100 cc. water.	2 5 per cent. KNO_3.	5 per cent. KNO_3.	5 per cent. $NaNo_3$.
	Gr'ms			*cc. Alk.*	*cc Alk.*	*cc Alk*	*cc. Alk.*	*cc. Alk.*	*cc. Alk.*	*cc. Alk*	*cc. Alk.*
1	2	100	1	1.4[1]	------	-----	5.6	6 8	.4[2]	.5[2]	.5[2]
2	1	100	2	------	7.4	8.1	8.8	------	------	.75[2]	------
3	1	100	½	-----	1.3[2]	1.5	2.8[3] 2 0-2.3	2.8	.9[2]*	----	------
	1	100	1	.45[2]	.8	1.5	2.5	3.1	.25	-----	------
4	1	100	½	..	2.4[2]	3 55[2]	5 15	6.3	.95[2]	..	------
	1	100	1	-----	2.9[2]	4.7[2]	7.3	8 85	1.0[2]	-----	------
5	1	100	½	1.4[4]	-- .	-----	2 2 2 2	-----	.8 .7	------	------
	1	100	1	-----	------	-----	2.8 2 8	------	.8 .8	-----	------

[1] Stood 18 hours and then filtered turbid, though double filter was used; result too high.

[2] Filtered turbid; results too high. [2] * 3 p. ct. KNO_3 used.

[3] Used as in washing the "yellow precipitate," one portion of 100 cc. was added, stirred, and allowed to stand 15 minutes, and filtered off; then another 100 cc. portion was added and treated in the same way.

[4] Stood 24 hours before a clear filtrate could be obtained.

time before filtration for most of it to settle to the bottom of the beaker. The washes were then filtered through double filters, evaporated to dryness, (when nitric acid was present) heated in air bath until nitric acid was driven off, and titrated. It was found very difficult to prevent the molybdic acid from passing through the filter when water was used as the solvent. It would remain suspended in very finely divided state in water for 24 hours and pass through the filter. The results for the water-solubility are therefore generally too high. This is also true to a less extent of the solubility in 2.5, 3, and 5 per cent. potassium nitrate solutions and in the 5 per cent. sodium nitrate solution; and to a still less extent of the solubility in 2 and 5 cc. of nitric acid solutions.

The results are not all uniform but fairly so when the same molybdic acids were used. None of these molybdic acids were pure, Numbers 1 and 2 contained considerable quantities of ammonium nitrate and ammonium molybdate and perhaps some sodium molybdate. Numbers 3, 4, and 5, were washed by decantation for a day or more with large quantities of dilute nitric acid and finally once or twice with water, and contained, so far as we ascertained, only molybdates as impurities. These impurities did not, we think, materially affect the solubility of these acids in the wash solutions.

The results, at any rate, are of value in showing the comparative solvent action of the different washes for molybdic acid under conditions similar to those in which they are used in the method.

They show that water and sodium and potassium nitrate solutions have very little solvent action upon molybdic acid, while that of the stronger nitric acid solutions is quite considerable. After all, these results may represent more nearly what we want than if pure molybdic acids had been used; for in the volumetric method it is not a solvent for molybdic acid alone that is wanted, but for a mixture of molybdic acid and ammonium molybdate, perhaps in quite variable quantities.

Of the dilute nitric acid washes, the one containing 10 cc. 1.42 sp. gr. nitric acid in 100 cc. of the wash, was adopted, because it possesses good solvent power for molybdic acid and is of practically the same acidity as the solution in which the precipitation of ammonium phospho-molybdate is made in the official method. The official molybdic solution contains nearly 15 cc. 1.42 sp. gr. nitric acid in 50 cc.; and a solution requiring 50 cc. of molybdic solution to precipitate the phosphoric acid in it usually has a volume near 100 cc.; the two would give a volume of 150 cc., containing about 10 cc. nitric acid in the 100 cc. We know that precipitation is complete in a solution of this acidity, and no solvent action takes place even on long standing. It therefore, seems reasonable to conclude that nitric acid of the same strength would exert little or no solvent action on the ammonium phospho-molybdate in the short time required to wash this precipitate.

Solubility of Ammonium Phospho-molybdate in the Foregoing Wash Solutions.—It now appeard desirable to investigate the solubility of ammonium phospho-molybdate in these same wash solutions. This was done by preparing a pure phospho-molybdate from sodium phosphate by precipitating with a deficient quantity of molybdic solution, pouring off the filtrate, washing by decantation with dilute nitric acid, and finally with water, to remove most of the nitric acid, and drying to constant weight at 130° to 150° C. This phospho-molybdate contained 3.789 per cent. P_2O_5, the theory being 3.783, showing that it was practically pure. The solubility (see table V) is expressed in terms of the number of cc. of standard volumetric alkali required to neutralize the phospho molybdate dissolved. One cc. of this alkali equals 1 milligram P_2O_5.

From .75 to 1.4 grams of the prepared phospho-molybdate was shaken up in flasks with 500 cc. of the wash solutions. 200 cc. of this was filtered off at the end of 24 and 106 hours, respectively, evaporated to dryness (when nitric acid was present), the nitric acid driven off, and the residue titrated. The phospho-molybdate settled in only two or three of these washes in less time than 24 hours, and even then the very fine particles remained suspended in the water solutions, and it was found impossible to get clear filtrates from them. The results for water-solubility are therefore too high. For the reason just stated, the solubility of ammonium phospho-molyb-

TABLE V.—Solubility of Ammonium Phospho-molybdate in Wash Solutions.

	Amount of solution, cc.	Time of standing, hours.	Water at 65° C.	Water at laboratory temperature, about 27° C.	2 cc. HNO_3 in 100 cc. wash.	5 cc. HNO_3 in 100 cc. wash	10 cc. HNO_3 in 100 cc. of wash at 65° C.	10 cc. HNO_3 in 100 cc. wash at laboratory temperature	20 cc. HNO_3 in 100 cc. wash.	3 per cent. KNO_3 solution.
			cc. Alk.	cc. Alk.	cc Alk.	cc. Alk.	cc Alk.	cc. Alk.	cc. Alk.	cc. Alk.
.75 to 1.4 gram substance stood in 500 cc. of the solutions for the times indicated and 200 cc. was taken each time for the test.	200	24	5.1[1]	.85[1]	.2	.25	20.1	.6	.75	.5
	200	106	6.0[2]	3.0[3]	2.05	5.5	16.75[2]	6.75	11.45	4.35
Results from allowing precipitates from 20 per cent. phosphate to stand in these solutions.	200	½	..	none	..	none	.....	none	none	none
	200	1	..	trace	..	trace	.....	trace	trace	trace

[1] These filtered very turbid; they had not settled in 24 hours.
[2] These stood at laboratory temperature (about 27° C.) after first 24 hours.
[3] Filtered turbid; result too high.

date in the washes could not be determined for the times they would ordinarily stand in contact with the precipitate in washing by the use of the pure molybdate. If, however, the solubility of even this pure phospho-molybdate was proportional to the time of standing in the washes, the amount that would have been dissolved by all the washes (dilute nitric acid, potassium nitrate solution, and water) used in washing a precipitate in the ordinary 30 minutes required for washing could hardly have been found. On this basis a plus correction of about 0.016 of one per cent. would be necessary on the basis of 0.2 gram substance.

The solubility of the "yellow precipitate" just as it is precipitated in ordinary work, along with the salts carried down with it, was also determined in the wash solutions, by allowing 200 cc. of them to stand in contact with the precipitate for one-half and one hour respectively, after stirring thoroughly. The precipitates settled completely and quickly in this way. In none of these washes could more than a trace of phosphoric acid be found.

Again, all the washings (3600 cc.) from 6 determinations of phosphoric acid in two phosphate solutions (3.30 per cent. and 19.83 per cent.) were combined, evaporated down, and the phosphoric acid in them determined by the gravimetric method, when 0.38 milligram P_2O_5 was found, corresponding to a plus correction of 0.03 of one per cent. on basis of 0.2 gram substance. A similar result was

obtained from the washings from 8 determinations on the same samples.

These results indicate that while the wash solutions used in the volumetric method have marked solvent power for molybdic acid, they have practically no solvent action on ammonium phospho-molybdate, and that a correction for ordinary work at least is not necessary. There is danger, however, of mechanical loss The precipitate is first washed by decantation with dilute nitric acid and potassium nitrate, and afterwards with water to remove nitric acid. In this after washing, when all the salts have been removed from the precipitate and as much as 600 or 700 cc. has been used, the precipitate begins to pass through the filter mechanically and settle to the bottom of the receptacle. We have not, however, found it necessary to wash with more than 300 cc. of water in our present manipulation of the method. We consider that 500 or 600 cc. of water may be used without this loss, but the filtrate should be closely observed when the washing goes beyond this amount.

Investigation of Molybdic Solutions.—Besides the comparison of the aqueous molybdate of Pemberton with the official molybdic solution recorded in a preceding portion of this bulletin, nine other molybdic solutions of different formula, including five or six of those most highly recommended by different analysts and the remainder of our own making, have been tried. The formula of these solutions need not be given. They varied quite widely in the proportions of molybdic acid to free nitric acid and ammonium nitrate as well as in degrees of concentration. Without going into a detailed discussion of the results and the advantages possessed by the different molybdic solutions for different purposes, we will merely state that we found the official molybdic solution [made by dissolving 100 grams of molybdic acid in 400 grams, or 417 cc., of ammonia of 0.96 sp. gr., and pouring this into 1250 cc., or 1500 grams, nitric acid of 1.20 sp. gr.,] to be the one best suited to the volumetric method for very small quantities of phosphoric acid, of one per cent. or less. For percentages larger than one, the foregoing solution with the addition of 80 extra cc. of 1.42 sp. gr. nitric acid, or 5 cc. to each 100 cc. of official molybdic solution, was found to be the best. 100 cc. of this latter solution contains practically 6 grams molybdic acid, 4.6 grams ammonium nitrate, and 35 cc. free nitric acid of 1.42 sp. gr., which is about the largest quantity of free nitric acid in proportion to molybdic acid that can be used in a molybdic solution not to interfere with quick and ready precipitation of phosphoric acid. When a larger proportion of free nitric acid is in the solution, precipitation of phosphoric acid is either incomplete or is very materially retarded. This modified official molybdic solution, containing the larger amount of nitric acid, can be readily used for all percentages of phosphoric acid, but it contains rather too much free nitric acid to allow of the quickest precipitation of very small quantities, but by extending the time of precipitation to 8 or 10 minutes it will be found to be complete, even when very small

amounts are present. The judgment and manipulation of the analyst will, however, be the best guide as to whether he will employ the solution containing the larger amount of nitric acid for all percentages, or whether he will only use it for those above one per cent. or so, and use the regular official solution for less amounts.

Effect of Organic Acids in Preventing Deposition of Molybdic Acid.—Jüptner[1] has successfully used 0.2 to 6 grams tartaric acid per 100 cc. of molybdic solution for preventing the deposition of molybdic acid in the determination of phosphorus in steel. One to four grams of citric acid to 100 cc. of the two foregoing molybdic solutions were employed in the hope of accomplishing the same object. When 3 and 4 grams of citric acid was used, precipitation was not complete in 15 or 20 minutes, and with smaller quantities (1, 1.5, and 2 grams) precipitation was complete in a reasonable length of time (7 to 15 minutes), but the results at best showed no advantage over those obtained on the same samples with the molybdic solutions without the presence of citric acid.

Acidity of Ammonium Phospho-molybdate.—Hundeshagen[2] has stated that it required 23 molecules of Na_2CO_3 (or Na_2O) to neutralize the ammonium phospho-molybdate containing one molecule of P_2O_5. H. Pemberton[3], Jr., working upon a solution of c. p. di-sodium hydrogen phosphate, found that 23.2 molecules of Na_2CO_3 were necessary to neutralize the ammonium phospho-molybdate containing one P_2O_5 molecule; a second determination[4], however, working in the same way, gave him 22.99 molecules.

In the course of my work upon the volumetric method, I have determined the acidity of ammonium phospho-molybdate in two ways. First, by finding the amount of alkali necessary to neutralize the ammonium phospho-molybdate formed from a given amount of phosphate. This was done by dissolving 10 grams of c. p. di-sodium hydrogen phosphate in a liter of water, carefully measuring out 20 cc. portions, precipitating with molybdic solution, washing thoroughly according to our practice in the volumetric method, and titrating with alkali. The results obtained are as follows:

	Cc. of phosphate solution used.	Equaling grams $Na_2HPO_4.12H_2O$.	Equaling grams P_2O_5.	Cc. KOH solution required to neutralize phospho-molybdate formed.
1	20	.2000	.039652	39.80
2	20	.2000	.039652	39.80
3	20	.2000	.039652	39.80

Dividing the weight of P_2O_5 by the number of cc. of alkali required to neutralize the phospho-molybdate formed, we find that 100 cc. alkali has neutralized an amount of ammonium phospho-molybdate containing 99.628 milligrams P_2O_5.

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1 Abs. Expt. Sta. Record, **6**, 610.
2 Zeitschrift f. Anal. Chemie., **28**, 141–172.
3 Jour. Am. Chem. Soc., **15**, 382.
4 Jour. Am. Chem. Soc., **16**, 278.

The alkali was now titrated against $\frac{N}{2}$ hydrochloric acid, carefully standardized by silver nitrate to contain 18.2285 grams HCl per liter. 100 cc. of the alkali equalled 64.5 cc. of the $\frac{N}{2}$ acid, which contained 1175.74 milligrams HCl, which in turn equals 1519.3 milligrams K_2O, or 2228.6 milligrams K_2CO_3. Therefore, 1519.3 milligrams K_2O equal 99.628 milligrams P_2O_5 in the yellow precipitate.

Dividing each of these by its molecular weight, we obtain:

For P_2O_5 .... $\frac{99.628}{142.06} = 0.7013$

For K_2O .... $\frac{1519.3}{94.22} = 16.125$

Then, $P_2O_5 : K_2O = 0.7013 : 16.125 = 1 : 22.993$.

The relation between standard alkali and P_2O_5 in "yellow precipitate" was now determined by preparing pure phospho-molybdates by precipitating sodic phosphate with a deficient quantity of molybdic solution, pouring off the filtrate, washing by decantation, first with dilute nitric acid and then with water, and drying at 130° to 150° C. to constant weight. These phospho-molybdates contained 2.232 per cent. nitrogen (average of 7 analyses), the theory being 2.238; and 1.645 per cent. phosphorus, the theory being 1.651. The following results were obtained by titrating a portion of three of these:

	Grams ammonium phospho molybdate used.		Cc. standard alkali required to neutralize.
1	1.2322	=	46.55
2	0.8050	=	30.45
3	0.7955	=	30.10
Total	2 8327		107.10

100 cc. of alkali has, therefore, neutralized 2.6449 grams of ammonium phospho-molybdate, which multiplied by 3.783 (the per cent. of P_2O_5 in the yellow precipitate) gives 100.05 milligrams P_2O_5 in 2.6449 grams of this salt, and which correspond to 100 cc. of the alkali used.

100 cc. of this alkali was found as before to equal 64.74 cc. $\frac{N}{2}$ hydrochloric acid, which contains 1180.14 milligrams HCl, and which in turn equals 2,237.08 milligrams of K_2CO_3. Therefore, 2237.08 milligrams K_2CO_3, equal the 100.05 milligrams of P_2O_5 contained in the 2.6449 grams of "yellow precipitate."

Dividing by molecular weights, there is found:

For P_2O_5 .... $\frac{100.05}{142.06} = 0.7042$

For K_2CO_3 .... $\frac{2237.08}{138.22} = 16.185$

Therefore, $P_2O_5 : K_2CO_3 = 0.7042 : 16.185 = 1 : 22.983$.

It has, therefore, required practically 23 molecules of K^2CO_3 (or of K_2O) to neutralize an amount of ammonium phosphomolybdate ($6 NH_4.P_2O_5.24MoO_3$) containing one molecule of P_2O_5.

On this basis, one cc. of a standard alkali containing 18.17106 grams of KOH per liter would equal one milligram P_2O_5.

100 cc. of this solution will neutralize 32.38 cc. of normal acid; and either the acid or alkali to be used in the volumetric method can be made by diluting 323.8 cc. of the corresponding normal solutions to 1000 cc.

The above calculations are based upon the following atomic weights:

Na, 23.05	K, 39.11	N, 14.03
H, 1.007	C, 12	
P, 31.03	Cl, 35.45	
O, 16.	Mo, 96	

Results by the Volumetric Method as now worked in this Laboratory, Compared with Gravimetric Results.

The writer was again the reporter of the Association of Official Agricultural Chemists on methods for determining phosphoric acid for 1894–'95, and the foregoing investigation was made with a view of revising the method for trial by the Association, and for perfecting it, if possible, for use in this laboratory. The method was accordingly changed quite materially, re described to accord with the results of the preceding work, and sent to various official and other chemists for trial with three samples upon which to conduct the work. These samples were:

No. 1 was a c. p. di-sodium hydrogen phosphate solution, containing 10 grams of the salt per liter, the theoretical percentage of P_2O_5 in it being 19.826.

No. 2 was solution No. 1 diluted with 5 parts of water, and therefore contained 3.304 per cent. P_2O_5 in 50 cc.

No. 3 was a mixed fertilizer.

The results obtained in this laboratory on these samples by the gravimetric and volumetric methods and presented to the Association, are brought together in table VI.

These results are what may be termed *most excellent*. It may not be out of place here to state also that the results of nine other chemists on these same samples, including 31 determinations on sample No. 1, and 33 on No. 2, excluding three results, are as good as our own. 73 per cent. of all the results of 13 chemists on sample No. 1 are within 0.05 of one per cent. of the theory, and 93 per cent. within 0.10 of one per cent., there being only three results varying more than one tenth. On sample No. 2, 85 per cent of all results are within 0.05 of one per cent. of the theory and all are within one-tenth.

This summary of results of members of the Association of Official Agricultural Chemists by the volumetric method are in rather marked contrast to the results of this and all previous years by the

TABLE VI.—Total Phosphoric Acid determined by Gravimetric and Volumetric Methods.

Analyst.	Sample No. 1. Methods and washing.				Sample No. 2. Methods and washing.				Sample No. 3. Methods and washing.			
	Official gravimetric.	Volumetric.	Washing, water.	Difference + greater—less than gravimetric.	Official gravimetric.	Volumetric.	Washing, water.	Difference + greater—less than gravimetric.	Official gravimetric.	Volumetric.	Washing, water.	Difference + greater—less than gravimetric.
	Per ct.	Per ct.	cc.	Per ct.	Per ct.	Per ct.	cc.	Per ct.	Per ct	Per ct.	cc.	Per ct.
W. M. Allen	19.93	19.81	275		3.38	3.28	265		12.50	12.32	275	
	19 97	19.84	250	—.11	3.39	3.27	300		12 59	12 39	300	—.179
	19.96	19 88	285			3.27	275	—.109		12.39	350	
						3.29	275					
						3.28	300					
						3.27	275					
C. B. Williams	19.91	19.80	220			3.32	210			12.32	240	
		19.85	230			3.32	220			12.32	270	
		19.85	250	—.073		3.32	205			12.32	235	
		19 85	250			3.32	220			12.42	220	
F. B. Carpenter	19.83	19.85	275		3.38	3.32	250		12.43	12 39	250	
		19.87	275	+.03	3.33	3 34	250	—.006	12.37	12.43	250	+.01
B. W. Kilgore	19.96	19.83	280		3.38	3.32	300			12.40	225	
	19 89	19 83	280	—.12	3.39	3.31	200			12.40	190	
	20 00	19.83	250		3.40	3.30	2[illegible]0	—.083		12.37	200	
						3.30	210			12.37	250	
Average	19.93	19.84	......	......	3 38	3.302	......	......	12.475	12.37		
Theory	19.826	19.826	......	......	3.304	3.304						
Variation of lowest result from theory	.004	.026	......	......	.026	.034						
Variation of highest result from theory	.174	.054	......	......	.096	.036						

official gravimetric method, and also to the results by the volumetric method as worked last year. The results last year by the volumetric method were considered, on the whole, as encouraging, while the method as worked this year has given extremely good results in all hands.

The volumetric and gravimetric methods have been compared in this laboratory upon quite a variety of phosphates and fertilizer materials of varying percentages. The results follow in table VII.

These volumetric results show close agreement with the gravimetric ones, though they are generally slightly lower than the latter. When we observe the close agreement of duplicate results by the volumetric method and remember the tendency of the molybdate method to give high results, we have ground for believing that the volumetric results are more nearly correct.

TABLE VII.—Determinations of Phosphoric Acid in Various Materials by Volumetric and Gravimetric Methods.

Analyst, and Material Used.	Number.	Gravimetric method.	Volumetric method.	Washing, water.	Difference, greater + less— than gravimetric method.
C. B. Williams.		*Per ct.*	*Per ct.*	*cc.*	*Per ct.*
Cotton-seed meal	1	.08	.08	130	.00
Fertilizers and fertilizing materials.	2	.37	.35	160	—.02
	3	1 32	1 28	100	—.04
	4	1.50	1.45	240	—.05
	5	.88	.79	215	—.09
	6	.65	.61	260	—.04
	7	.64	.61	250	—.03
	8	1.27	1 25	240	—.02
	9	1.29	1.25	250	—.04
	10	4.96	4.95	155	—.01
	11	4.98	4.92	180	—.06
	12	11.80	11.80	120	.00
	13	11.58	11.45	250	—.13
	14	9 77	9.80	240	+.03
	15	10.04	10 05	220	+.01
	16	9.54	9.45	260	—.09
	17	10.72	10.65	270	+.07
	18	6.46	6.40	230	— 06
	19	6.55	6.60	250	+.05
	20	5.45	5.50	290	+.05
	21	6.52	6.60	280	+.08
	22	7 47	7 44	240	—.03
			7.44	230	
	23	7.42	7.44	250	+.04
			7.48	230	
	24	17.55	17.52	260	—.03
		17.55	17.52	260	
Florida phosphate	25	38.12	37.80	260	—.30
			37.84	260	
Acid phosphate	26	15.49	15.35	290	—.14
Acid phosphate	27	13.27	13.15	280	—.12

TABLE VII.—Concluded—Determinations of Phosphoric Acid, etc.

Analyst, and Material Used.	Number.	Gravimetric method.	Volumetric method.	Washing, water.	Difference, greater + less— than gravimetric method.
W. M. Allen.		Per ct.	Per ct.	cc.	Per ct.
Mixed fertilizer	1	11.58	11.45	250	—.09
			11.48	260	
			11.53	280	
Mixed fertilizer	2	9.54	9 50	275	—.02
			9.53	285	
Acid phosphate	3	15.49	15.47	250	—.04
			15.43	275	
Mixed fertilizer	4	10.72	10.70	260	—.03
			10.67	275	
B. W. Kilgore.					
Mixed fertilizer	1	9.77	9 76	275	.00
		9 75			
" "	2	9 03	8.96	210	—.07
" "	3	10.67	10.66	220	—.01
" "	4	11.58	11.60	275	+.02
" "	5	9.77	9 76	275	—.01
" "	6	10.04	10 01	275	—.03
" "	7	9.54	9.48	275	—.06
Acid phosphate	8	15 49	15.42	275	—.07
Insoluble —	9	2.57	2.60	230	+.03
Reporter's sample No. 1 ([1])	10	19.96	19 88	260	—.05
		19 89	19 88	260	
Mixed fertilizer	11	10 72	10.68	275	—.04
Acid phosphate	12	13.27	13.21	275	—.06
Mixed fertilizer	13	11.71	11.63	275	—.08
" "	14	11.88	11.75	275	—.13
" "	15	9 43	9.38	250	—.05
" "	16	9.71	9.80	230	+.09
" "	17	10.38	10.30	250	—.08
Bone meal	18	20 53	20.48	210	—.05
Acid phosphate	19	15.02	15.10	220	+.08
Reporter's sample No. 2 ([2])	20	3.38	3.30	220	—.08
		3.39	3.31	220	
Reporter's sample No. 3	21	....	12.43	260	
			12.43	260	
			12 45	260	

[1] C. p. $Na_2HPO_4.12H_2O = 19.826$ per cent. P_2O_5.

[2] Theory 3.304 per cent. P_2O_5.

Results on a High Grade Phosphate.—To see how the volumetric method would work with a phosphate of very high percentage, and to see how the results by the two methods would compare on it, a high grade Florida phosphate was submitted to analysis, with the following results:

	C. B. Williams, Analyst.	B. W. Kilgore, Analyst.
Gravimetric method	38.12 per cent.	
Volumetric method	37.80 "	37.80 per cent.
	37.84 "	37.88 "
Less by volumetric method	.30 "	

The foregoing results by the volumetric method, our work upon it, and experience with it generally lead us to consider it a more accurate and reliable method than the molybdate-magnesia method. Since the change of temperature of precipitation, precipitating reagent, wash solutions, and manner of washing, from what they were in the Pemberton method, the difficulty in getting occasionally very high results in the midst of good ones, and which did so much to destroy faith in the method, seems not to occur under the new method of procedure. The accuracy, reliability, and rapidity of the method, (a man being able to make about twice as many determinations by it as by the gravimetric method), causes us to feel that the large amount of time which we have put upon the method has been well spent and will soon repay us in the saving of time on this class of work in our own laboratory, to say nothing of the service it may be to others. I am indebted to Messrs. C. B. Williams and W. M. Allen for assistance in carrying out the foregoing work.

The Details of the Volumetric Method.

The method, as we have found it to give the best results, may be described as follows:

Weigh 2 grams of substance and make solution by one of the following methods: (1) Evaporate with 5 cc. of magnesium nitrate solution, ignite, and dissolve in hydrochloric acid. This is for organic materials. (2) Dissolve in 30 cc. of concentrated nitric acid with a small quantity of hydrochloric. (3) Add 30 cc. concentrated hydrochloric acid, heat, and add cautiously in small quantities at a time about 0.5 gram of finely pulverized potassium chlorate. These (2 and 3) are for ordinary phosphates and fertilizers. (4) Dissolve in 15 to 30 cc. of strong hydrochloric acid and 5 to 10 cc. of nitric. This is for phosphates containing much iron and aluminum. Method 2 is preferred when these acids are a suitable solvent for the material. Make up to 200 cc., (or any other convenient volume) measure out 20 cc. for total phosphoric acid, or for percentages above 5 or 6; and 40 cc. for insoluble phosphoric acid, or for percentages below 5 or 6, corresponding to 0.2 and 0.4 gram substance, respectively; add about 5 cc. concentrated nitric acid, when method 2 for solution has been used, and about 10 cc. when method 1, 3, or 4 has been used. Now add ammonia until precipitate just begins to form, dilute the high percentage solutions to about 100 cc. and low percentage ones to 60 or 75 cc., digest in water-bath at 60° to 65° C., and after filtering the molybdic solution to be used in this method,

precipitate, not using any greater excess of molybdic solution than is necessary to insure complete precipitation; let stand in bath 6 minutes from the time the molybdate is added, and filter as quickly as possible upon a three-inch Hirsch funnel, whose perforations are covered with a disc of soft filter paper, or in a Gooch crucible with one or two pieces of filter paper, slightly larger than the bottom of the crucible, tightly pressed against it, or upon a filter made by using a platimum cone or disc, well filled with holes in a three-inch funnel and covering with coarse asbestos, using the pump in all cases. Filter paper may be used but the other filters in the order named are much to be preferred. It is *especially urged* that the three-inch Hirsch funnel be used where possible, as it permits of *rapid filtration* and easy and thorough washing. Wash the precipitate twice by decantation with dilute nitric acid, using 50 to 75 cc. each time and *agitating thoroughly*, once by decantation with the same amount of 3 per cent. potassium or ammonium nitrate, then on to the filter and with 200 to 500 cc. water, (250 cc. is usually enough) or until no longer acid. Now wash the precipitate with filter back into the beaker, titrate with potassium hydroxid and back with nitric acid, using phenolphthalein as indicator and adding acid until color disappears.

In washing by decantation, if the precipitate is allowed to settle completely each time, no trouble will be experienced in the after washing. Where the phosphoric acid is below one per cent. the precipitation is not so rapid as in larger percentages and may require 8 or even 10 minutes to be complete.

Reagents Used in the Volumetric Method.

Molybdic solution.—Dissolve 100 grams of molybdic acid in 400 grams, or 417 cc., of ammonia, sp. gr. 0.96, and pour the solution thus obtained into 1500 grams, or 1250 cc. of nitric acid, sp. gr. 1.20, and add 80 cc. nitric acid, sp. gr. 1.42. Or to each 100 cc. of the official molybdic solution, (the above formula without the 80 cc. nitric acid) add 5 cc. 1.42 sp. gr. nitric acid. This solution should be filtered each time before using.

Dilute nitric acid wash.—Dilute 100 cc. of 1.42 sp. gr. nitric acid to 1000 cc.

Potassium or ammonium nitrate wash.—Dissolve 3 grams of either in 100 cc. of water.

Alcoholic solution of phenolphthalein.—100 cc. to 1 gram.

Standard potassium hydroxid.—This solution should contain 18.17106 grams potassium hydroxid to the liter. One cc. of this solution equals one milligram P_2O_5 (one per cent. P_2O_5 on basis of 0.1 gram substance), and 100 cc. will neutralize 32.38 cc. normal acid, and can be made by diluting 323.81 cc. of normal potassium hydroxid (which has been freed from carbonates by barium hydroxid), to 1000 cc.

Standard nitric acid, of the same strength, or one-half the strength of alkali. Hydrochloric or sulfuric acids will answer.

II. THE ESTIMATION OF PHOSPHORIC ACID IN SOILS BY DOUBLE PRECIPITATION WITH MOLYBDIC SOLUTION, AND TITRATION OF THE AMMONIUM PHOSPHO-MOLYBDATE WITH STANDARD ALKALI.

BY C. B. WILLIAMS.

The accurate estimation of the small quantities of phosphoric acid usually present in the acid extract of soils is a question that has given no small amount of trouble in soil analysis. There seems to be two main difficulties: First, in the precipitation with molybdic solution in the presence of large quantities of iron and aluminum salts, compounds of these latter elements are also often precipitated with the ammonium phospho-molybdate, and are either dissolved by the ammonia wash or remain in the cone of the filter as phosphates, thus giving rise to either high or low results, unless special precautions are taken. In the second place, very small quantities of phosphoric acid are not precipitated readily by magnesium chlorid mixture and usually require long standing to be complete, in which case the precipitate is very liable to contain an excess of magnesia, thus giving rise to high results.

Some work in the laboratory of this Station upon the samples sent out by Prof. A. M. Peter, reporter on soils of the Association of Official Agricultural Chemists, indicate that these difficulties are readily overcome by the following procedure:

The hydrochloric acid extract of the soil is obtained[1] by digesting the soil in 1.115 sp. gr. acid, at the temperature of boiling water and under atmospheric pressure for 10 hours. The organic acids (1 per cent. citric acid and 0.63 per cent. oxalic acid solutions) extracts[2] are obtained by digestion at laboratory temperature for five hours. Care must be taken to destroy all organic matter in the hydrochloric acid extract, as well as in the organic acids extracts. This is done in the former case by adding about 1 cc. concentrated nitric acid for every 3 cc. of the portion taken for analysis, and evaporating to 2 or 3 cc. concentration, and in the latter cases, by evaporating the extracts to dryness, and igniting with the addition of a small quantity of nitric acid, until organic matter is completely destroyed. These residues are now dissolved up to convenient volumes, and portions corresponding to 18 or 20 or more grams of soil, and portions of the hydrochloric acid extract corresponding to one or more grams of soil (according to the richness in phosphoric acid)

[1] Bul. 43 Div. Chem., U. S. Dept. Agr., p. 387.
[2] See report of A. O. A. C., reporter on soils for 1895.

are taken and after adding about 15 grams ammonium nitrate are precipitated with a large excess of molybdic solution (30 cc. is usually enough). Let stand 4 hours, filter and wash with water twice.

TABLE VIII.—Volumetric Determination of Phosphoric Acid in Soils by Double Precipitation with Molybdic Solution—1st at 40° C. in Water-bath with 30 cc. of Official Molybdic Solution; 2d at 65° C. in Water-bath with concentrated Nitric Acid and 2 cc. of Molybdic Solution, Compared with Official Gravimetric Method.

No. of sample.	Hydrochloric acid solution.			Citric acid solution		Oxalic acid solution.	
	Official gravimetric method.	Volumetric method		Volumetric method		Volumetric method.	
		1st solution	2d solution.	1st solution.	2d solution	1st solution	2d solution.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct*	*Per ct.*	*Per ct.*	*Per ct.*
1	.4505	.4170	.4069	.0282	.0290	--------	.0505
		.4170	.4069	.0282	.0287	--------	.0505
		.4170	.4069	.0282	.0287	--------	.0510
		.4170	.4069	.0282	.0287	--------	.0510
2	.1720	.1826	.1826	0119	.0146	--------	.0060
		.1775	.1826	.0119	.0146	--------	.0060
		.1826	.1928	.0119	.0146	--------	.0065
		.1826	.1928	.0122	.0152	--------	.0065
3	.3956	.3767	3867	.0233	.0255	--------	.0475
		.3869	3867	.0233	.0255	--------	.0475
		.3869	.3867	.0233	.0255	--------	.0483
		.3767	.3818	.0233	.0261	--------	.0483
		.3767					
		.3818					
4	.1932	.1828	.1929	.0157	--------	--------	.0087
		.1878	.1929	.0157	--------	--------	.0087
		.1928	.1929	.0157	--------	--------	.0087
		.1878	1878	.0162	--------	--------	.0084

Now dissolve the precipitate with dilute ammonia into the beaker used for precipitation, wash the filter with dilute nitric acid, and add concentrated nitric acid until precipitate begins to re-form; add 10 grams ammonium nitrate, digest in water bath at 65° C., add 2 cc. strong nitric acid with vigorous stirring, let stand 5 minutes, add 2 cc. molybdic solution and let stand 8 minutes more, filter, wash and titrate according to the volumetric method used in this laboratory[1]. The results presented in table VIII were obtained in the course of this investigation, and show very close agreement with each other on the same solutions.

[1] See previous description of volumetric method in this bulletin.

Cultivation of the Peach Tree

INCLUDING

I. THE PEACH TREE AND ITS PARASITES.
II. THE PLANTING, PRUNING AND CULTIVATION OF THE PEACH.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N C.

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THE CULTIVATION OF THE PEACH TREE

INCLUDING

I. The Peach Tree and its Parasites.
II. The Planting, Pruning and Cultivation of the Peach.

I. THE PEACH TREE AND ITS PARASITES.

By Gerald McCarthy, Botanist and Entomologist.

1. INTRODUCTION.

The peach tree is a native of the warm sandy valleys of Persia—a region whose soil and climate are very similar to the upland cotton region of the Southern States. In recent years, in many localities where cotton growing has ceased to be profitable, former cotton plantations have been largely transformed into peach orchards, and many hundreds of acres, from which pines have been cut, have been cleared and planted in peach trees. Where the most suitable varieties have been planted, the first or second crops of the finest peaches ever placed on the market have already been gathered and sold at prices far in advance of anything grown on these lands since the days when cotton brought 25 cents per pound.

It is possible that many, probably the majority, who have set out peach orchards during the last few years, or who will do so during the next few years, know little or nothing about the nature of the peach tree and the diseases to which it is liable. Under such circumstances disappointment and loss inevitably awaits many who trust to luck or chance to save their trees. Successful fruit growing now requires peculiar skill as well as industry. The most serious diseases of the peach tree are caused by the attacks of various species of insect, worm and fungous parasites. These parasites are organized living creatures, which increase and spread according to natural laws. Their power of multiplication is limited, and therefore their increase, and the consequential damage they cause the fruit grower, is at first comparatively slow. So small, however, are they that they usually work unnoticed by careless persons, until they have increased almost to their natural limitation. All these parasites are, in a large degree, dependent on and controlled by the weather. The usual process of infesting an orchard is as follows: (1), The planter of the orchard buys and sets out a lot of trees containing one, or a few trees

already infested by some parasite. From these trees, as centers, the parasite spreads in ever widening circles, or it may be, in the direction of the prevailing winds; or (2), in one of many possible ways the parasites are introduced from neighboring orchards, and from one or more centres spread over the orchard as aforesaid. In our State, where the cultivation of the peach in large orchards is of quite recent beginning, and the orchards still widely separated, the chances of local infection are few, and the infection, if it is found, will be more likely to come through importing from the older peach growing sections young trees already infested in the nursery with these parasites. Very naturally, then, the first four or five years of the life of such an orchard, will show scarcely any trace of disease, which is apparent to the untrained eye of the non-scientific observer. But despite this, the deadly parasite may be present and increasing to the limit of their power. Here and there will be found sick or dying trees. When a season, unfavorable to the peach tree and favorable to the parasites comes, there will be an apparently sudden and unaccountable outbreak of the disease, which may cause the owner urgently to seek a remedy when the opportunity for applying practicable treatment has passed, and when nothing but the most heroic measures can prevent the ruin of the orchard.

It is of the utmost importance, then, that those who propose to invest their money in peach orchards should, in good time, inform themselves thoroughly upon the nature of this tree, and the enemies to which it is exposed. Reckless and irrational methods, such as have been too common in cotton growing, will prove even more rapidly and completely ruinous in peach culture. The present bulletin is an attempt to bring together in concise form the principal facts concerning the parasites of the peach tree, now present or likely to be introduced into North Carolina.

2. APPARATUS AND FORMULAS.

Before proceeding to describe in detail the different parasites of the peach tree, it will be convenient, for reference, to bring together in one chapter, facts concerning apparatus and parasiticidal formulas.

In planting and pruning the peach in our climate, the best authorities recommend that the tree be headed low—from 8 to 16 inches from the ground—never more than two feet, and that the annual growth be severely cut back, so as to maintain a close round head, which will bring the fruit within easy reach of the pickers without the use of ladders. This will, at the same time, protect the tender bark of the trunk from "sun scald," one of the most common and serious injuries. Where trees are grown in this way, the ordinary knapsack sprayer will give excellent satisfaction. There are on the market several varieties of this style of pump, almost any of which will give good results, provided it is made *entirely* of brass and copper, and has the Vermorell nozzle. At the N. C. Experiment Station and the Experimental Farm of the State Horticultural So-

ciety, we have used the "Garfield" and Eureka knapsacks and can cordially recommend these. (See figure 1.)

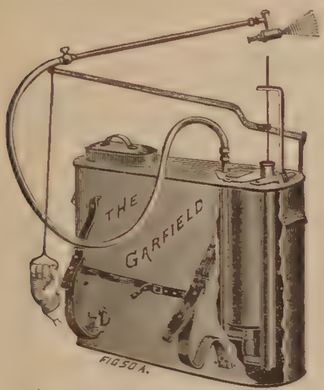

Fig. 1. Knapsack Sprayer.

Fig. 2. Bucket Sprayer.

The chief disadvantage of this style of sprayer is the amount of time consumed in refilling, as the tanks hold only 4 or 5 gallons. Where one has only a few trees, a good implement is the bucket sprayer (fig. 2), which is now made by most pump manufacturers. For orchards of more than 100 trees, a barrel sprayer, having two delivery hose and nozzles, mounted on wheels or placed in a cart, drawn by a mule, will be more satisfactory. To properly manage such a sprayer, three men are required. One in the cart to drive the mule and work the pump, and one at each nozzle to direct the spray. We have used and can recommend the "Double Acting," "Perfection" and "Climax," all brass barrel pumps with automatic agitators. See figures 3, 4 and 5.

Fig. 3. Double Acting Sprayer.

Fig. 4. Perfection Sprayer.

There are on the market several makes of automatic or horse-power sprayer, of which Fig. 6 is a type. This style of sprayer is not suitable for Southern fruit growers. Fig. 7 shows a recently devised implement for injecting liquids into the soil to kill worms and fungi, which prey upon the root part of plants.

Fig. 5. Climax Sprayer.

Parasiticidal Formulas.

The value of arsenical sprays—Paris green, London purple, &c., against noxious insects, is now very generally known. But not all beginners in peach culture know that this tree is very intolerant of these poisons, and that the tree may be permanently injured or killed outright by many of the popular formulas, or by an application that would have no injurious effect upon apple or pear trees. The use of arsenites may, however, be at times absolutely necessary, but it is an evil necesstiy, and cannot be accomplished without some damage to the tree. Peach growers must beware of looking on spraying as a cure. all which renders hygienic precautions unnecessary. Where the peach grower is well informed, foresighted, and industrious, the necessity for using arsenical sprays can be largely avoided, as will be indicated in treating of the different pests.

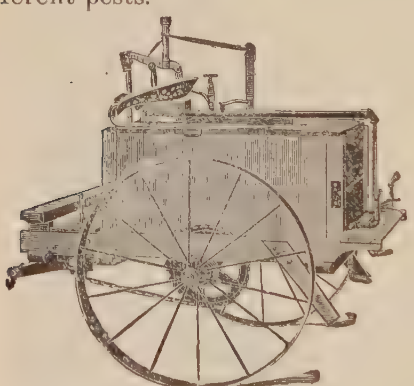

Fig. 6. Horse Power Sprayer.

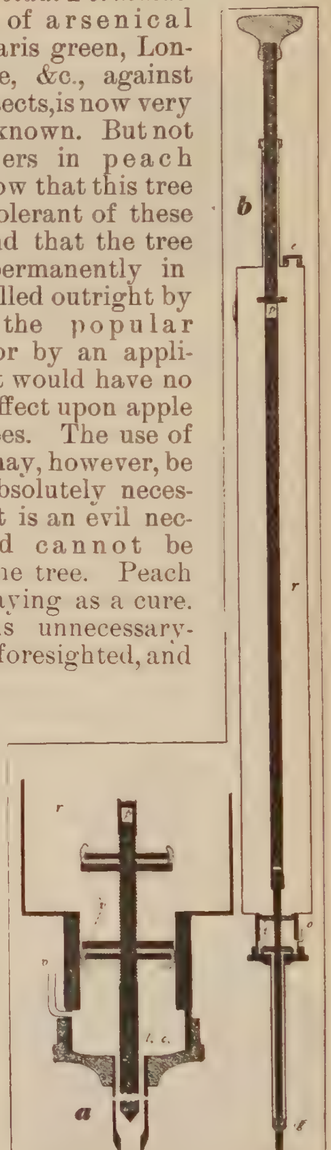

Fig. 7. McGowan Injector.

The following formulas may be used on the peach tree where such treatment is prescribed:

FORMULA 1.—PARIS GREEN OR LONDON PURPLE (*arsenites*).

Paris green or London purple	3 or 4 ounces.
Fresh building lime	6 or 8 ounces.
Black molasses or thin flour paste	1 quart.
Water	one barrel or 50 gallons.

Directions:—Slake the lime in sufficient water to make a cream-like mixture. Strain the lime and remove hard lumps, then stir in the arsenite. Let stand for 24 hours or more, stir in molasses or paste, then dilute and use. Be particular that the pump used has an effective automatic agitator, for unless the arsenite is kept stirred, it will settle to the bottom and the last few gallons of the liquid will be so heavily charged with the poison that the trees upon which it is sprayed must suffer. This formula is for destroying gnawing insects only, beetles, caterpillars, &c.—it has little or no effect on sucking insects.

Owing to the fact that Paris green has advanced in price, an equally effective and much cheaper arsenite can be substituted for it. This has been devised and recommended by B. W. Kilgore, of this Station. It is made as follows:

White arsenic	1 pound.
Fresh building lime	2 pounds.
Water	3 or 4 gallons.

Directions:—Boil the arsenic and lime for half an hour in the water, replacing evaporated water with hot water. Before using, dilute to 200 gallons, or 4 barrels. White arsenic in 10 pound lots can be bought for 8 cents per pound, while Paris green costs 40 to 50 cents per pound. Hence for extensive use, the white arsenic and lime formula is much the cheapest. White arsenic is not very soluble in water, but more soluble in ammonia. It must never be used upon trees until it has been boiled with lime, as directed, as it would destroy the foliage and young wood.

FORMULA 2.—KEROSENE EMULSION.

Soft soap ½ gallon, or hard soap ½ pound.

Kerosene oil	2 gallons.
Water	1 gallon.

Directions:—Boil the soap in the water until all is dissolved, then remove from the fire and add the kerosene. Churn vigorously for ten minutes and then pass it through the sprayer twice, spraying it back into the same vessel. This will cause the oil and soap to form

a permanent emulsion, which will not separate on cooling. Before using, dilute the emulsion with *nine times* its bulk of cold water. This mixture is for use against sucking insects, like plant lice, scales, &c. The emulsion must be carefully and thoroughly made, or it will burn the foliage.

FORMULA 3.—TOBACCO DECOCTION.

Tobacco leaves or dust, dried	1 pound.
Refined carbolic acid	1 teaspoonful.
Water	3 gallons.

Directions:—Boil the tobacco in the water for half hour, replacing the water evaporated by hot water. Add the acid and use hot, without further dilution. This formula is effective against soft, smooth insects, like plant lice, "mealy bugs," &c., but is more adapted for indoor than for orchard use.

FORMULA NO. 4.—POTASH SOAP.

Concentrated potash lye	1 pound.
Crude petroleum, fish oil or cotton-seed oil	3 pints.
Crude carbolic acid	½ pint.
Water	3 gallons.

Directions:—Boil the lye in the water until dissolved, then add the oil and acid and boil for two hours, replacing from time to time the water evaporated. Let stand until cool, when it may be cut with a knife. For use, dissolve one pound of this soap in ten gallons of water and use hot. This is more effective than the tobacco decoction, and better adapted for outdoor use. Use for plant lice.

FORMULA NO. 5.—WINTER SCALE WASH.

Rosin	15 pounds.
Caustic soda, 70 per cent	4½ pounds.
Fish oil or cotton-seed oil	2 quarts.
Water	1 barrel.

Directions:—Boil the rosin, soda and oil in 5 or 6 gallons of water, until the rosin and soda have dissolved. Then dilute to one barrel and use. This is for winter use against armored scales. Must not be used during the growing seasons.

FORMULA NO. 6.—SUMMER SCALE WASH.

Rosin	10 pounds.
Caustic soda, 70 per cent	2½ pounds.
Fish oil or cotton-seed oil	1 quart.
Water	1 barrel.

Directions:—Prepared same as No. 5. For summer use. Much less effective than No. 5, and not superior to kerosene emulsion.

FORMULA NO. 7.—BISULPHIDE OF CARBON AND VASELINE.

Mix in equal proportions. Should be used as soon as mixed. It should be handled with care, as it is volatile and explosive when brought near a flame.

FORMULA NO. 8.—BORDEAUX MIXTURE.

Copper sulphate	6 pounds.
Fresh lime	6 pounds.
Water, one barrel or	50 gallons.

Directions:—Dissolve the copper sulphate in a barrel of water by suspending it in the water in a coarse sack. Shake the sack from time to time to accelerate the solution. Slake the lime separately and strain it, then stir slowly into the barrel. Use within 24 hours, as it soon spoils. This is the standard remedy for all kinds of plant diseases.

FORMULA NO. 9.—COPPER SUCRATE.

Copper sulphate	6 pounds.
Building lime or washing soda	4½ pounds.
Molasses	2 quarts.
Water, one barrel or	50 gallons.

Directions:—Dissolve the copper sulphate in a barrel of water, slake the lime or dissolve the soda separately, strain and stir slowly into the barrel. After boiling has ceased, add the molasses and stir for ten minutes. Let stand for one hour and then use. This formula is, in effect, equal to No. 8, and adheres much longer to the foliage. It is, therefore, preferable in rainy seasons.

FORMULA NO. 10.—CORROSIVE SUBLIMATE WASH.

Corrosive sublimate	2 ounces.
Hard soap 5 pounds, or soft soap	10 gallons.
Alcohol or wood spirit	1 pint.
Water	sufficient.

Directions:—Dissolve the sublimate in the spirit, stir it into the soft soap, or into a solution of the hard soap in ten gallons of water. If necessary, add water sufficient to make a good paint. Apply with a stiff brush.

FORMULA NO. 11.—CEMENT WASH.

Hydraulic cement	5 tablespoonfuls.
Sour milk or buttermilk	2 gallons.

Directions:—Mix and use at once. Apply with a stiff brush.

3. INSECT ENEMIES OF THE PEACH TREE.

The peach tree—*Prunus persicæ*—is a member of the Rose family of plants, which includes all the best fruits of the temperate zone, viz., peach, plum, apricot, nectarine, cherry, apple, pear, quince, the haws, blackberry, raspberry and strawberry. With the plum, cherry, nectarine and apricot, it forms a natural and well defined sub-family, popularly called the Stone fruits. The stone fruits being so closely related, are all more or less subject to the same parasitic diseases, and insects and infection may proceed from any one genus to any other genus or species. This fact is important and should be always kept in mind, for it is to little purpose to clear peach trees of parasites, if plum, cherry, nectarine or apricot trees in the neighborhood are left infested. Wild plum and cherry trees are common nurseries and sources of infection for cultivated peach trees.

Root Borer of the Peach Tree.

Fig. 8. Parent moths of peach borer.
a, female; *b*, male—exact size.

The worst insect pest of the peach tree is the Root Borer, the larval form of a slender steel-blue, wasp-like, day flying moth, *Sanninia exitiosa.* This is a native insect which, before the introduction of the peach, infested the wild plums and cherries of the country. The insect may be still found upon these trees and also to some extent upon the cultivated plums and cherries, but not to same extent that it infests the peach. The winged insects usually appear in the orchards soon after the trees put forth their leaves. The female lays some 50 to 100 eggs—one or two on each tree at the base of the trunk, or on the "collar" just below the surface of the soil. The eggs hatch in about a week and the worm at once begins to gnaw the bark and bore its way down into the root. The worm has weak jaws, and seems instinctively to take the right direction to reach the root where the wood is softer than above ground. It lives in the root for one year and comes forth a winged insect the succeeding spring, and lays the eggs for the next brood as stated. The presence of the worm is always betrayed by the copious exudation of gum which issues from the roots near the base of the trunk.

Remedies: There are a large number of remedies for this pest which are more or less successful. When only a few trees are kept, the best plan is to go over them in the fall, or any time after August, and with a sharp knife cut out and kill all worms found. The popular plan of postponing the worming until spring is very bad policy, as the borer has already done its worst by that time and is not then easily found. Where the peach is cultivated on a large scale, worming becomes very expensive, if not wholly impracticable. Some plan less laborious must be resorted to. A very popular and successful

plan in the peach regions of the West is "mounding." Early in spring, before the moths appear, the earth is drawn about the base of the tree and trampled hard, the mound being about twelve inches high. This mound will in a great measure prevent the winged insects then in the roots from coming forth, and those that do get out will be forced to lay their eggs so far up on the trunk that the weak jawed grub is unable to reach the roots, but dies of exhaustion after making a shallow hole. The mound must be removed soon after the moths disappear—about July 15 in central North Carolina. If the mounds are left, the tree will send forth roots from above the collar, and these roots will be easily injured by droughts and frost. Mounding requires a good deal of labor, and the removal of the mounds in July or August is apt to be neglected. Where such is the case, the use of washes intended to keep off the moth or poison the worm may be, upon the whole, the most practicable plan for large orchards. Among the many washes, probably the best, are Formulas 10 and 11. Apply these with a stiff brush from two or three inches below the surface of ground to eight to twelve inches above. This must be done as soon as the first moth is seen in the orchard, and must be repeated every two or three weeks, as long as the insects are seen. The worm will be poisoned by the corrosive sublimate almost at the first mouthful. But the liquid must be thoroughly applied, so there will be no weak spot for the pest to get through. Do not use more of the sublimate than indicated, as it might injure the tree. While the sublimate wash is always effective, it is dangerous to have in the house, as the substance is very poisonous. A non-poisonous wash which gives very good results is Formula No. 11. The cement soon hardens and forms a coating round the tree, through which the weak-jawed worm is unable to break, and hence soon dies of exhaustion. This wash must be repeated every two or three weeks until July 15, as the growth of the tree causes it to crack. Do not use more cement than prescribed, as if too thick the cement coating may prevent the natural expansion of the trunk.

The Curculio.

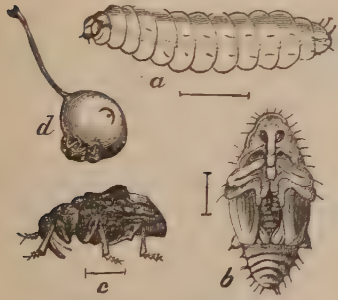

Fig. 9. Curculio.
Hair lines show exact size.

The notorious plum curculio *Conotrachelus nenuphar*, attacks the peach when plums are scarce.

Remedies: The peach, unlike the plum, has a fuzzy coat which holds arsenites well. The poison may be added to one of the fungicidal mixtures, as given in the formulas. Never use more of the arsenite than the formula calls for. That quantity applied as specified does not injure the edibility of the fruit. Usually one treatment made when the fruits are the size of marbles will be all that is necessary. Another plan is to jar them upon sheets wet with kerosene. (See next head.)

The June Beetle.

In some neighborhoods, more especially where the soil is sandy, the June Beetles, *Lachnosterna fusca*, and *L. tristis*, the parents of the common "white grubs," are very destructive to the spring growth of young trees. The beetles settle in swarms on the tender young twigs, and being voracious, often eat or kill shoots a foot or more in length. The work of destruction is generally done at night, and its cause is, therefore, not always suspected.

This beetle usually appears in Central North Carolina during May, and disappears in July. The female beetle lays her eggs among the roots of grasses. These soon hatch, and the grubs begin to feed upon the roots they find about them. They remain in the ground for three years, coming forth as winged insects. For this reason these insects do not occur in large numbers in the same locality oftener than once in three years.

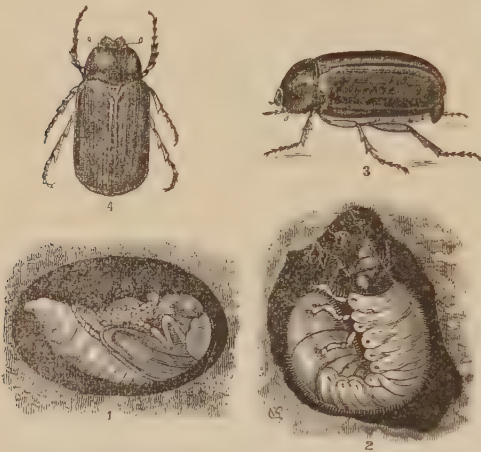

Fig. 10. June Beetle; 1, pupa; 2, larva, 3 and 4, winged beetle—all exact size.

Remedies: The young shoots of the peach tree are much too tender to withstand Paris green or any other acrid poison. The only practicable remedy, therefore, is hand picking. The beetle, being nocturnal in its habits, should be sought after dusk in the evening or before sunrise in the morning. The latter is the best time. Use a shallow vessel containing some water and kerosene oil. Bend the young shoots over this and shake the insects into it, or spread under the tree a sheet wet with kerosene and jar the beetles upon it. They will be killed at once by the oil.

The Rose Beetle.

The Rose Beetle, *Macrodactylis subspinosa*, is another troublesome pest on sandy lands. This beetle, like the June Beetles, lays its eggs in the roots of grasses and weeds. The grub, however, lives but one year under ground, changing to the winged form and issuing from the ground the succeeding spring. The winged beetles live only for a couple of weeks, lay eggs for the succeeding brood and then die. During their brief career they often do immense damage, as they appear in vast numbers and select by preference the flower buds of the rose, peach, grape, and other fruits. This beetle is yellowish gray in color and about one-half inch long, with large spiny legs.

Remedies: The Rose Beetle seems proof against all poisons. Boiling hot water has been used against them with good results where

they infest rose bushes and low plants, but this is scarcely practicable in case of the peach, as it will be nearly impossible to keep the water hot enough. Hand-picking must be resorted to. To do this the best plan will be to shake them upon a sheet wet with kerosene oil, as recommended for the June Beetle and described under that head. The best time to do this is in early morning, when the insects are half torpid and will readily fall from the tree when it is jarred.

The Peach Tree Louse.

In some years the leaves of the peach, about the time they are half or two-thirds grown, become thickly infested with small plant lice resembling the lice so common on cabbage, but black in color. These spring lice have hatched from eggs laid upon the twigs the preceding fall. All of them are females, and when ten or twelve days old they begin to reproduce young living lice by the so-called parthenogenic process. The progeny are also all females, and when about ten days old these produce others, and so on. These pests multiply with astonishing rapidity during the spring months, but later their natural enemies—the lady-bugs, lace-wing flies, and other predacious insects—make their appearance and soon destroy most of the lice. These useful insects then disappear themselves on account of lack of food, and the remnant of the lice begin to multiply once more; but by this time the leaves and branches have become less succulent and the fruit is about gathered Little attention is, therefore, as a rule, paid to the second crop of lice. As soon as cold weather begins there is a winged generation produced, which lay eggs in the usual way. These are deposited in the cracks and crevices of the bark of peach trees in the neighborhood, where they remain unhatched until spring. Each kind of tree has a specific aphide or louse, which attacks that species of tree and no other. The figure, No. 10, shows the aphide which generally infests the apple. The true peach aphide differs from this only in color and minor points

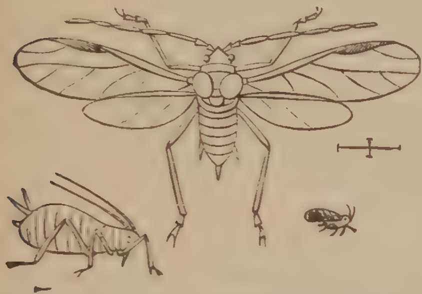

Fig. 11. Plant Louse, winged and winglest forms—magnified. Hair lines show exact size.

Fig. 12. Lady Bug and larva.

Fig. 13. Lace wing Fly, eggs and larva.

of little consequence to practical men. In North Carolina apple trees are not generally attacked by the aphide, but peach, plum and cherry are often badly injured.

Remedies: The plant aphides have numerous and powerful enemies among predacious and carnivorous insects and birds. The insects most active in destroying them are the small beetles, popularly called "lady-bugs," and their larva. The lace-wing fly is another insect very useful in this connection. Unless the lice become very abundant and threaten serious injury before their natural enemies appear, it will scarcely pay to attempt to destroy them by artificial means. But upon nursery stock and young orchard trees, especially tender trees like the peach, the lice are very apt to do great damage before they are checked by their natural enemies. Hence, upon such trees they should be destroyed as soon as they appear. The best means are the tobacco decoction and potash soap, used as a spray sufficient to wet the foliage thoroughly. The kerosene emulsion is more certain in its effect, but unless properly made, it is apt to burn the foliage and young shoots. Usually only one spraying will be required. This should be applied in early morning.

The Periodical Cicada.

The periodical cicada, *Cicada septendecim*, more commonly but wrongly called Seventeen Year Locust, when it appears upon the

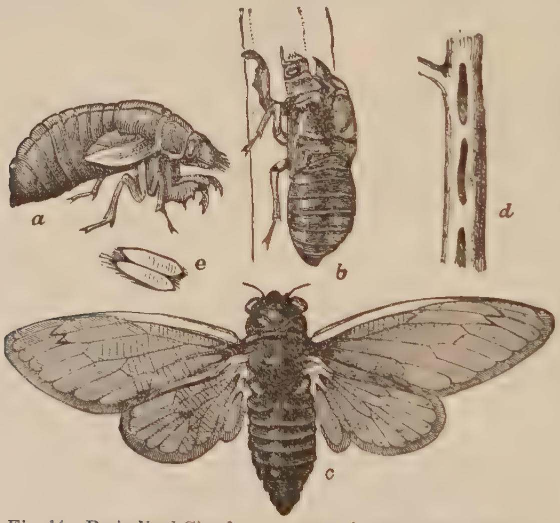

Fig. 14. Periodical Cicada. *a*, pupa; *b*, cast-off pupal skin; *c*, imago; *d*, egg slits or nest in a twig; *e*, eggs—exact size.

wing, often causes serious damage to young peach trees by puncturing the trees and laying the eggs therein. The larva of this insect lives for thirteen to seventeen years in the ground and feeds upon roots. As many as a thousand of these insects have come out of

the ground beneath a single tree, and hence it is very likely that such a number feeding upon the roots do very much of the damage which is imputed to the borer. The winged insects when they appear unusually come out of the ground in May or June. They live only for a week or two and eat nothing. The eggs deposited in the twigs hatch out in a short time, and the larva at once comes out and drops to the ground if the twigs are still on the tree. It burrows at once into the ground and proceeds to feed upon the roots it finds there.

Remedies: This is a very difficult insect to deal with, but fortunately is not very common. As it does not feed it cannot be poisoned in the winged state, and it is hardly practicable to combat it in the larval or underground state. All twigs containing eggs should be cut off and burnt. The insects, when they alight upon the trees, may be jarred upon oiled sheets as already advised for other insects.

The Soft Scale.

The "Soft Scale" or Peach-tree Bark-louse is scientifically known as *Lecanium persicae.* It is blackish in color and nearly hemispherical in form. The scales usually attach themselves to the smooth bark of young twigs. Probably much of the twig blight or "die back" complained of is due to these scales.

Remedies: Prune off and burn badly infested twigs as soon as noticed. As a precaution, in early spring just before the buds start, spray the trees with kerosene emulsion (formula 2), or Potash soap (formula 4). If they still infest the trees repeat the potash soap, spraying about June 15. The treatment will be much more effective if given when the lice are just hatched, which, in ordinary seasons, occurs during the first half of June.

The West Indian Peach Scale—*Diaspis lanatus.*

A new peach tree scale, from the West Indies, has made its appearance in the United States, but so far has not been observed in North Carolina. It is known to exist in Florida, Georgia, District of Columbia and probably exists in other places. It attacks the peach, plum, grape, cotton, okra and many other plants, and is likely to become a most destructive pest in our southern peach orchards. This scale is white or grayish; the male scales are long and slender, resembling the oyster-shell scale of the apple. The female scales are nearly circular. They usually occur in groups on the older twigs or branches.

Remedy: Same as for the soft scale. The kerosene emulsion applied in early spring, and rubbed in with a brush, will give best results.

The San José Scale.

The San Josè Scale, *Aspidiotus perniciosus*, the most destructive scale of deciduous fruits, long known on the Pacific slope, has re-

cently found its way to this side of the continent, and has created no little alarm. It was at first noticed in Virginia in 1893, but has since been found in nearly every State on the Atlantic coast. It has not yet been found in North Carolina, but its appearance is only a question of time. The dissemination of this pest in the Eastern States has been traced, in nearly every case, to the two large nurseries in New Jersey, which imported it from California with the Japan plum, some six or eight years ago. This scale infests, worst of all, the the pear, apple and plum trees, but has also been found upon peach, cherry, rose quince and many kinds of nut trees and ornamental flowers. This scale is nearly circular in outline, with a blackish or yellowish dot near the center. The scales attack the whole tree—fruit, young branches and even the trunk down to the ground. On the fruit and young twigs, the surface around the scales is stained red. This does not occur with other scales, and hence is a specific characteristic of the San Jose scale.

Remedies: This is a difficult pest to extirpate; it is enormously prolific, and, except the first two or three days of its life, is protected by a nearly impermeable shield or scale. Its effect upon the trees is much more destructive than any other scale with which we are familiar. Those who have it in their orchards will scarcely be able to extirpate it except by cutting down and burning the infested trees. Careful and thorough work will enable us to keep it in check and prevent its spread.

In California, the rosin-soda-oil washes (formulas 5 and 6), have given the best results against this pest. So far as these have been tried in the Eastern States they have not given such satisfaction, and, being rather expensive, will not be likely to be much used except in localities where, from climatic and other causes, they act more effectively. California has a very dry climate, and washes remain on the trees a long time. In our section rains are plentiful, especially in winter, and hence these washes are leached off before they have destroyed the insects.

The two most profitable and practicable remedies are the kerosene emulsion (formula 3) and the potash soap (formula 4). The kerosene emulsion should be used only while the trees are leafless, and preferably, just after the leaves have fallen in autumn and just before the buds start in spring. At these periods the scales are less benumbed by cold, and therefore more susceptible to the destructive action of the kerosene. At the times mentioned the emulsion may be used much stronger than the formula. One part of the concentrated emulsion to four parts of water has given very good results. It should be applied as hot as possible. Another good winter remedy is the potash soap, made according to formula No. 4, but instead of allowing it to cool and redissolve, use hot as soon as made, diluting the concentrated liquid soap with one half barrel or twenty-five gallons of hot water. For summer use, these two remedies are equally applicable but must not be used on the peach more concentrated than the formula prescribed. The potash soap, diluted accord-

ing to the formula, is the safest and will give good satisfaction if used three or four times during the growing season, say June 1, July 1, August 1 and September 1. The summer wash (formula No. 6), may be used instead, if the weather is as dry as it usually is in mid-summer. The kerosene emulsion will burn the foliage badly unless thoroughly well made.

Parasitic Nematode Worms.

In the lighter sandy soils of the South Atlantic coast, wherever the peach, plum, fig and grape are grown, there is known a disease called "Root Knot." The cause of this disease, according to a report made to the U. S. Department of Agriculture, by Dr. J. C. Neale, of Florida, is one or more species of nematode or "eel" worms (*Anguillula*), which infest the ground and fix themselves upon or within the roots of different species of plants. Besides the fruit trees above mentioned, these worms are very partial to the cow pea, peanut, radish, turnip, melons cucumber, okra and tomato. They also extensively infest the roots of purslane, rag-weed, Jerusalem oak, and spring or green pig-weed—all of which are among our most common weeds. These worms are most abundant in moist, sandy soils, especially such as have received a good coating of stable manure or a green crop turned under, and land recently cleared of oak or chestnut trees. They seem especially fond of the cow pea, and when this plant is grown upon old sandy fields, in the long-leaf pine region the root swellings, caused by the worms, are very common.

Remedies: Where peach orchards are planted upon sandy soil, and within the pine region, the cow pea may prove to be a source of infection. As green manurial crops, we can recommend the Lupines—yellow and blue—the sand vetch, *Vicia villosa*, common winter vetch, *Vicia sativa* and crimson clover, *Trifolium incarnatum*. Winter rye and barley may also be grown for this purpose. All these are fall sown crops, which must be turned under or removed in spring, leaving the ground free and clear during the summer. The weeds mentioned as specially infested by these worms, must be carefully kept out of orchards. The root crops mentioned above, should not be grown in or near orchards.

As regards topical treatment, there is none very promising. In Europe, for this and similar diseases of grape vine roots, carbon bisulphide is successfully employed. But for use on a large scale this treatment will be found too expensive, and moreover, the roots of the peach are more sensitive to chemicals than grape roots are. An application of 1,000 pounds of kainite per acre, in autumn, will do much to drive these pests away, and is a fertilizer required by the tree. Where the preventive measures above indicated are faithfully carried out, no great damage need be feared from these eel worms. So far as known these worms do not occur outside of the long leaf pine region.

4. THE FUNGOUS PARASITES OF THE PEACH TREE.

Peach Yellows.

The most destructive disease of the peach tree is the still obscure disease known as "yellows." This is now considered as the result of infection by a microbe similar in nature to those which cause cholera, yellow fever, etc., in human beings. The microbe has not yet been isolated and has no name. The "yellows" has destroyed the peach orchards of whole counties in Michigan, New Jersey, Delaware, Maryland and Pennsvlvania. It is now quite common in Virginia and Georgia. In the latter State it exhibits certain peculiarities which causes it to be there called Rosette, but the latter seems a mere variety of the "yellows." Neither "yellows" or "rosette" is certainly known to exist in North Carolina at the present time, but we have no good reason for presuming on the permancy of this exemption. Our present freedom is undoubtedly due largely to the sparseness of peach orchards in the State, and to the very general use of native seedlings and home-grown budded stock. It would be well for the State if planters of peach trees would confine their purchases to home-grown stock. Peach trees should not be purchased in any of the above-mentioned States, nor from peddlers or irresponsible nurserymen, who may sell the stock procured from some of the infected States.

Peach "yellows," in its latter stages, is characterized by the growth of the twigs in bunches, the twigs being slender, with few and narrow leaves, which soon show the sickly yellow color which has given the common name to the disease The fruit always *ripens several weeks before its time*, is abnormally splashed red, and *bitter or tasteless.* The production of premature, red-splashed, bitter or tasteless fruit is the specific and certain symptoms of "yellows." But trees infested by borers may cause premature fruit, which, however, is not spotted nor tasteless. The infection usually begins near the top and works downward. Its progress is slow, taking three or four years to kill the tree, but from the first, the fruit is worthless.

Many cases of so-called "yellows," that is, trees showing sickly yellow foliage, are due to borers in the roots or to the soil lacking some plant food needed by the tree, such as potash, phosphates or nitrates. But this is not true "yellows," and does not cause the premature ripening of abnormally high colored and bitter or insipid fruit, nor the characteristically bunched growth of the twigs.

Remedies: There is no remedy for the "yellows" except the spade and axe. Attempting to cure such trees is time and money thrown away. A genuine case of "yellows" has never been cured. While the tree stands it is a constant menace, a source and centre of infection to surrounding trees. As soon as discovered it should be rooted up and entirely burnt; another peach tree may safely be planted on the spot thus vacated, and the orchard thus kept intact.

Fig. 17. Peach Yellows. 1. Summer growth. 2. Autumn growth.

3 2 1

Fig. 18. Peach Rosette. 1. Healthy. 2. Diseased. 3. Badly diseased.

Brown Rot.

Fig. 19. Withered peaches, diseased by Brown Rot.

Brown rot of the peach and other stone fruits, and also quince, is caused by a fungous parasite, *Oidium fructigena.* The fungus attacks both the fruit, where it causes the rotten spots, which soon become covered with brownish powder—the reproductive spores of the fungus—and the tips of the twigs, where it produces the blackening known as twig blight. The twigs are usually infected during the summer or fall, but do not always show the effect until the succeeding spring. The fruit is usually intected after it has become full grown and before ripening. Most of the rotten fruit falls to the ground, where it is usually allowed to lie and decompose. Some of the infected fruits wither and dry up, still remaining attached to the tree even after the leaves have fallen. The disease may develop in apparently sound fruit after it has been picked, and be transmitted to other fruits.

Remedies: The first and altogether essential precaution is to gather up and destroy all rotten fruits and all fruit pits from the ground. Remove all withered fruit and all twigs showing "blight." Burn these. Rake up clean all leaves and burn them as soon as possible after they have fallen. In spring, as soon as the fruit buds start, sprinkle the ground under the trees with air-slaked lime, using enough to cover the ground. It will be well also to spray the trees a few days before the buds open, using either the Bordeaux or copper sucrate mixtures, preferable the latter. Spray again after the flowers have fallen, and repeat once every three or four weeks. For all treatments after the second, dilute the mixtures by adding one-third more water than the formulas call for. Never use *Eau Celeste* on the peach. If the preliminary sprayings are attended to in proper season, and the cleaning up of the orchard is thoroughly

done, there will not be much trouble from rot, provided there are no other sources of infection. It must be remembered that the plum, cherry and quince are attacked by this fungus and may transmit it to the peach. Wild plum trees, in the vicinity, may cause an outbreak of this and other destructive diseases in a peach orchard.

PEACH SCAB OR MILDEW.

Fig. 20 Peach Mildew.

Peach scab, or as it is called in its earlier growth "mildew," is caused by a fungous parasite, *Podosphæria oxyacanthæ.* It first appears about the time the fruit is half grown, or a little before, and then shows as a small irregular frost-like spot on the surface of the fruit. Later these spots darken and harden into scabs, and frequently the fruit cracks open to the pit. The fungus also attacks the leaves but does less damage than some other leaf diseases. Cracked and scabby fruit was observed quite plentiful this year (1895) in some peach orchards bearing their first crop. It is a disease likely to give much trouble in the future.

REMEDIES: Any of the standard fungicidal sprays, but more especially the Bordeax and Copper Sucrate mixtures will destroy the fungus, if applied in time, which is, when the frost-like patches appear on the leaves or fruit. For use on the peach tree, the standard formulas, as given in this bulletin, may be reduced by adding one-half more water than the formula calls for, i. e., where the formula requires 50 gallons of water, add 75 gallons. All diseased fruit, whether on the ground or on the trees, must be gathered once a week and destroyed, with the disease spores they contain.

Fig. 21. *a*, Young twig diseased by Exoascus (peach leaf curl). *b*, Leaf diseased by Exoascus—exact size.

Peach Leaf Curl.

In some seasons soon after the leaves on the peach have attained their full grewth, they become curled or puckered and soon after fall off. The fruit, set before the leaves fall, soon falls also. The trees usually put out a second crop of leaves, but no fruit. This disease is caused by a fnngous parasite, *Exoascus deformans*. This fungus attacks the leaves only, never the fruit. The fall of the fruit is caused by the lack of nourishment induced by the previous disease and fall of the leaves. The second growth of leaves so exhausts the tree that the succeeding year's crop is light, if any.

Remedies: Gather and burn all diseased leaves as soon as they fall. Spray early, as already indicated for peach rot. Spraying with copper sucrate just before the buds start, is of special value in localities where this disease is common.

Fig. 22. Peach leaf Curl—common form.

Shot-Hole Disease.

The leaves of the peach often show numerous small round holes, as though a charge of shot had been fired through them. These

holes are caused by the attack of a fungous parasite, *Cercospora persica*, which first appears on the leaves when they have nearly attained full size. It shows as small reddish circular patches, which soon fall away leaving the holes.

Remedies: Hygienic measures and spraying are advised as already indicated for peach rot. It is scarcely necessary to say that when trees are sprayed for one disease, that treatment will answer at the same time for all other fungous diseases, provided the spraying is done early enough to forestall the fungus.

Root Rot or Pourridie.

Pourridie is a disease of the roots of different species of shrubs and trees, caused by a parasite fungus *Demataphora necatrix.* This fungus is especially common on the roots of the different species of oak and chestnut trees; and when land freshly cleared of these trees is planted in peaches, the disease is almost certain to invade the roots of the latter. Such has been the experience of some peach orchards, recently planted upon land which had been cleared of a growth of Black Jack oak and scrubby post-oaks. The way such land is cleared leaves the soil full of small roots of the former growth. Many of these roots support a growth of the fungus, which, while it prefers to live upon living roots, is able to exist for an indefinite period on the dead roots in the soil. The symptoms of this disease is a general yellowing of the foliage, with feeble growth and narrow leaves. The entire fruit crop of a diseased tree may fall about the time it is full grown, but when this stage is reached, the tree usually dies also before the succeeding spring. If such a sickly tree is carefully dug up so as to get all the roots, many of the smaller roots will be found soft and some absolutely rotten. If the bark of some of the soft roots is lifted off, which is easy to do, underneath will be found a copious stratum or covering of white lint-like filaments which are the mycelium or root system of the fungus. This disease seems peculiar to warm climates, being probably checked by the deep freezing of the ground in cold regions.

Remedies: This is a pest extremely difficult to circumvent, after it is well established in peach orchards. The soil is apt to become filled with infected roots, which are left there when the dead trees are dug or pulled out. When orchards are planted on land filled with infected oak roots, we have a very difficult task. In Europe this disease is well known to fruit growers, but it there attacks chiefly the grape vine. Against this, and other root parasites, European fruit growers apply, on an extensive scale, carbon bisulphide and sulfocarbonate of potassium, which are injected into the soil by specially constructed instruments, resembling the McGowan Injector. (See Fig. 7.) In a smaller way it may be done by making holes about six inches deep at intervals three feet apart and pouring into each one-third ounces, or about a teaspoonful of the chemical. The holes are then filled up and trampled hard and the bisulphide left

to volatalize and permeate the soil. The amount of the chemical used varies from 80 to 200 pounds per acre. On strong clayey soil, the chemical is used pure, but on light sandy soil the pure chemical vaporizes too quickly to give the best results. On such soil it is customary to mix the bisulphide with an equal bulk of crude vaseline. This mixture reduces the volatility of the chemical so much that its period of activity is increased more than ten times. While carbon bisulphide used in this way is undoubtedly efficacious in vineyards, its effects in a peach orchard is not certainly known. The roots of the peach tree are much more tender than those of the grape. This subject will be further investigated at this Station during the summer of 1896. In the mean time, we can advise nothing better than the careful removal and destruction of all diseased trees. The disease once in the roots, cannot be dislodged by any practicable method, and is sure to destroy the tree. The trees should be carefully dug (not pulled up) so as to get all the rotten wood, and the whole should then be burnt. Leave the hole unfilled for a year, and throw into it two or three shovel fulls of gas-house lime, or if this cannot be had, as the next best thing, use air-slaked lime and kainit.

5. LEGAL MEASURES FOR REPRESSING INFECTIOUS DISEASES OF THE PEACH AND PLUM.

The peach and plum are the two most successful and profitable tree fruits for the lighter class of soils throughout the eastern and central districts of the State. Experience has shown that nowhere in the world can finer fruit of these kinds be produced than in our State. Both these fruits belong to the same genus—*Prunus*—and both are liable to the same or closely related parasites. The growing of these fruits in large commercial orchards is yet a comparatively new industry in North Carolina, and we are, as a consequence, yet free from the worst and most destructive diseases of these fruits which have devastated older fruit-growing regions. It is quite possible, at a very small cost, by legally enforced precautionary measures, to prevent the entrance or spread of these diseases which, if left to run their natural course will eventually cause losses of millions of dollars to the fruit growers of the State. The older fruit-growing States are now fully awake to the necessity of such laws. The diseases we have most to fear are Black Knot, already present, "Yellows" and San José Scale which, if not already present, will soon appear.

Annexed is the New York law, with some few amendments, which may serve as a suggestion for a law to be adopted in this State:

The New York Yellows and Black-Knot Law, Amended to Include the San José Scale.

Section 82. The Prevention of disease in fruit trees.—No person shall knowingly and willfully keep any peach, almond, apricot

or nectarine tree, affected with a contagious disease known as "Yellows," or offer for sale or shipment, or sell or ship to others, any of the fruits thereof. Nor shall any person knowingly or willfully keep any plum, cherry or other trees, infected with the contagious diseases or fungus, known as black-knot, or the insect known as San Josè Scale or *Aspidiotus perniciosus.* Every such tree and the fruit of a tree, infected with such diseases, or the parasite which cause them, shall be a public nuisance, and no damage shall be awarded for entering upon premises and destroying such trees and fruit if effected with yellows, or for cutting away the diseased part of any tree infected with black-knot or altogether destroying such tree if necessary to suppress such disease, if done in accordance with the provisions of this article. Every person, when he becomes aware of the existence of such disease in any tree or fruit owned by him, shall forthwith destroy or cause such tree or fruit to be destroyed or the infected part to be cut away.

§ 83. Appointment and duties of the agent of the Commissioner of Agriculture.—When the Commissioner of Agriculture knows, or has good reason to believe, such contagious disease exists, or danger is justly apprehended of its introduction in any town or city in the State, he shall forthwith appoint a competent freeholder of such town or city as his agent, who shall hold office during his pleasure, and who shall within ten days after his appointment, file an acceptance of the appointment, with the constitutional oath of office, in the office of the town clerk of the town. Such agent, shall on or without complaint, whenever it comes to his notice that either of the diseases known as yellows, black-knot or San Josè Scale exists or is supposed to exist within the limits of the town or city, proceed without delay to examine the trees or fruit supposed to be infected, and if the disease is found to exist, a distinguishing mark shall be placed upon the diseased trees. If the disease is the black-knot, such distinguishing mark shall be placed on some affected part of the trees, or if in the judgment of such agent any such trees should be entirely destroyed, then the trunk of such tree shall be thoroughly girdled, and thereupon the owner notified personally, or by a written notice, signed by such agent, and left at his usual place of residence; or, if a non-resident, by leaving the notice with the person in charge of the trees or fruit, or in whose possession they may be. Such notice shall contain a statement of all the facts found to exist, with an order to effectually remove and destroy, by fire or otherwise, the trees or parts of trees so marked and designated, within ten days, Sundays excepted, from the day of the service of the notice. In case of fruit so infected, the notice shall require the person in whose possession or control it is found, to immediately destroy the same or cause it to be done.

§ 84. Proceedings in case of owner's failure to destroy.—If any person shall refuse or neglect to comply with the order of such agent to remove and destroy trees or parts of trees so marked by him, such agent shall cause such trees or parts of trees to be re-

moved and destroyed forthwith, employing all necessary assistance for that purpose; and such agent or his employees may enter upon any and all premises within the town or city for the purpose of such removal and destruction. Such agent shall be entitled to compensation for his services under this and the preceding sections at a rate of two dollars for each full day spent by him in the discharge of his duties, and the necessary disbursements paid or incurred by him, which, with the expense and removal and destruction of any such trees or fruit, shall be a county charge.

6. VARIETIES OF PEACHES.

In order that a peach orchard shall yield the most profit to its owner, it is necessary to plant the varieties most suitable for the district in which the orchard is to be located, and for the purpose the planter has in view.

We give below the list of peaches recommended for the three climatical districts of the State, with the Horticultural Society's remarks upon the same:

List of Peaches Recommended by the N. C. State Horticultural Society.

† Worthy of trial. * For home use. ** Tried and highly recommended.

Variety.	Size.	Color.	Season.	Origin.	District Valuat'n.			Uses and Remarks.
					Eastern.	Central.	Western.	
Alexander	medium	W R	E. Sum	Illinois	**	*	*	Market; best early peach; profitable; semi-cling.
Albright	large	W	L. Fall	N. C.	*	*	*	Very late; good for canning; cling.
Belle of Georgia	large	W	E. Sum	Georgia.	**	**	*	Large, good and prolific; July.
Bilyeu	large	W R	Fall	N. C.	**	*	*	Profitable shipper; free.
Champion	large	W	E. Sum	Illinois.	**	**	**	Best very early white peach; prolific.
Crawford E.	large	Y R	E. Sum	N. J.	**	**	*	Standard market; productive.
Connet's	medium	W	E, Sum	N. C.	*	*	*	Early and good; promising.
E. Tillotson	medium	R	E. Sum	?	**	*	*	Standard market variety.
Elberta	large	Y R	Sum'r	Georgia	**	*	*	Popular market variety.
E. Rivers	medium	R	E. Sum	England	**	**	*	Home mark't variety; tender.
Flater's St. John	large	Y R	E. Sum	America	**	**	*	Standard market variety.
Globe	v'y large	Y	L. Sum	America	**	**	*	Larger than Elberta, which it follows.
Hynes Surprise	large	W	E. Sum	America	**	*	*	Good market peach for sandy land only.
Lady Ingold	medium	R Y	E. Sum	N. C.	**	**	*	Fine market variety,
Mountain Rose	large	W	Sum'r	N. J.	*	*	*	Fine and prolific, free-stone.
Oldmixon F.	large	Y R	Sum'r	America	**	*	*	Old market variety.
Piquett's Late	large	Y	L. Sum	Georgia.	**	**	*	Best yellow late variety.
Scott	large	Y R	L. Sum	America	**	**	*	Good late variety.
Smock	large	R	L. Sum	N. J.	**	**	*	Standard late variety.
Sneed	medium	W	E. Sum	Ky.	†	†	†	New, promising early yeach.
Stump	large	R	L. Sum	N. J.	**	**	*	Standard late vafiety.
Thurber	large	W	Sum'r	Georgia	**	*	*	Fine summer variety.
Wheatland	largo	D R	Sum'r	N. Y.	**	*	*	New and promising.
White English	large	W	L. Sum	England	*	*	†	New and promisi'g late peach.
Wonderful	large	Y	L. Sum	N. J.	*	*	*	An improvement on Smock.

THE PLANTING, PRUNING, AND CULTIVATION OF THE PEACH.

By W. F. Massey, Horticulturist.

Peach trees for orchard planting should never be older than one year from the bud, and a medium to small size tree is better than one that is overgrown in too fertile a soil. We have long been satisfied that much of the short-lived character of the peach is due to the indiscriminate way in which the seed for growing the stock has been selected. Nurserymen accept any seed that they are assured came from a "natural" tree, *i. e.* one that has been grown from the seed, under the impression that such seed are necessarily better than those from a budded tree. The fact usually is that these seeds are often collected from stunted trees along fence rows and in old fields, and they are really inferior to seed from healthy orchard-grown trees of budded fruit. It is far more important that the seed from which the seedlings to be budded are to be grown should be from healthy and vigorous trees than that they should be natural seed.

Shall we Plant Seedlings or Budded Trees.

If the orchard is intended to produce fruit for shipment to the northern markets, it is not worth while to discuss the question as to which are better, seedlings or budded trees—for if they are for this purpose none but well known varieties can be used with any profit, and in no other way can we get these varieties except by using trees that have been propagated by budding from the best varieties. An orchard of trees grown from seeds will be comparatively worthless for shipping purposes, for the trees come in all characters from the seed, and we will have early ones, midseason ones, and late ones, good ones, inferior ones, and usually more of the latter than any others, all mixed up, so that no shipment can be made of a uniform quality, nor of sorts that have a name in the markets. The labor, too, of gathering such a mixed collection will be greater than if solid blocks of uniform kind were planted together, while the fact they must go into the market as unnamed seedlings, will of itself make the price less. If we are planting a small orchard for home use only, there is no chance that if we select seed from very superior fruit that we may get good fruit, even if not the same as that from which the seed came. But the seedlings from the superior fruit will not be likely to be any more long-lived than trees

budded on vigorous stocks from healthy trees. The more refined the product, and the further it is removed from the natural conditions, the more care is needed with it. This is as true with vegetable products as it is in animal life. Peach trees are, at best, not very long-lived trees, and constant care is needed to make any tree live out their true length of existence.

Site and Soil for a Peach Orchard.

The site for a peach orchard is the most important matter connected with its success in the South. Our Spring climate is notoriously treacherous, and the peach tree is easily excited into an untimely bloom, if planted in the wrong location. In this latitude the peach tree should be planted on a dry and well drained soil. One rather inclining to sand than clay is best, and the worst possible location is one that is well sheltered from the cold winds, either by forest growth on the North or by being on the southern or eastern slope of a hill. We should select the coldest possible location, either on top of a hill or on the northern slope, or on the north side of a forest. In such a situation the trees will be kept back from blooming as late as possible and the chances of their escaping late spring frosts will be much better. Some suppose that a barren soil is what a peach tree needs. No error could be greater. While a dry soil is best, a soil that is very deficient in fertility cannot long keep a tree in a healthy condition, and while we may grow a good orchard on a sandy soil by giving it the proper treatment as to fertilizers and the culture of renovating plants, it is not because the soil was thin, but because its mechanical condition was favorable. Nothing will take the place of abundant plant food in giving health and long life to the tree.

Planting an Orchard.

Assuming that the trees are to be bought from a nursery, is of the first importance that we should get good trees, and healthy ones, and it is important too, that we get them as near home as possible, not only to save transportation charges but to be sure of healthy stock. The disease known as the "Yellows" which has so decimated the peach orchards North, and the equally bad disease called the "Rosette" in Georgia, have neither of them as yet made any progress in North Carolina, and if we are to keep our orchards clear of them, we must be careful as to the stock we plant. We should therefore get the trees from home nurseries that are careful to avoid all danger of introducing these diseases.

The Kind of Trees to Plant.

There are two classes of trees offered by the nurseries, known respectively as "June Budded" and "Yearling" trees. The June budded trees are those which are budded the first season in June.

Buds set at that time begin to grow at once, and make little trees two or three feet high the same season. The yearling trees are those from buds set in August or September, which remain dormant during the winter, and grow through the whole of the next season, making a much larger tree. In these the root is of course two years old, while the June budded trees, planted at the end of the first season's growth, have root the same age as the tops. In this latitude we prefer to plant the June budded trees, as they are sufficiently large, do not cost more than half the price of the yearlings, cost less freight and are more certainly transplanted. Those who want a bigger tree, and wish to make the head higher from the ground may plant the yearlings.

Planting the Trees.

Having the trees, the next step is planting them. The preparation of the soil for a peach orchard should be of the most thorough character. If the subsoil is hard and clayey, even if well drained (and no land not well drained should ever be planted in peach trees), it should be deeply plowed and subsoiled to a depth of at least ten inches, while deeper will be better. In a deep sandy soil this will of course not be needed. The land should then be marked out with a plow, 16 to 20 feet each way, the wider distance for strong land. In well prepared land the only holes needed will be a cleaning out of the crossings of the plow, for a deep hole is not needed, as the tree should be planted no deeper than it stood in the nursery. The trees should be prepared for planting by carefully pruning the roots that have been bruised in taking them up, and also cut all the small and dried up fibres to a good sound part, for new fibres put out more readily from a clean cut surface than from a dried up rootlet. In setting the tree, see that the fine earth is well packed around the roots. Tight ramming of every inch of soil is much better than trying to settle the earth to the roots by pouring in water, for when the earth is at all clayey the settling with water soon leaves cracks around the root to admit the air with its drying effect. See that the trees line with each other perfectly, for nothing looks more slovenly than an orchard planted in crooked lines. If the trees are planted on a steep hillside, it is best to plant them on the contour of the land, without reference to the straight rows, so that in cultivating each row may form a terrace.

Pruning the Tops After Transplanting.

As soon as the trees are set they should be headed back to the point where it is proposed to start the head. No branches that the tree has made in the nursery should be allowed to remain, and the main stem should be cut off at about twenty to twenty-four inches from the ground. This at once relieves the tree of the surplus top to correspond with the mutilated roots, but it prevents the swaying of the tree in the winds as it would if the top is allowed to remain untrimmed till spring.

Starting the Top.

As soon as growth begins in the spring, select three or four of the best situated buds near the cut end of the stem, to form the future head of the tree, and rub off and keep rubbed off, all other shoots that start from the stem. If one of these shoots seems inclined to take the lead of the others in the first summer's growth it should be pinched at the tip so that it can be overtaken by the others, and a well balanced head started. The next winter's pruning will consist in cutting back the shoot made the first year one halk, pruning to a bud on the outside so as to continue the open and spreading form of the head. The growth that comes toward the centre of the tree during this summer should be thinned, by rubbing out shoots as soon as they appear which are not wanted. Subsequent pruning will consist in shortening back annually part of the last season's growth, always remembering that the peach bears its fruit only on one-year wood, and the pruning should be directed towards keeping the young wood well distributed through the tree and preventing it getting too thick at any point

Cultivation of the Peach Orchard.

Clean culture must be the rule with the peach orchard during its whole life. Not that it need be deeply plowed, quite the contrary; for we wish to encourage the roots to feed near the surface and in the best soil, under the influence of the heat and oxygen of the air. But all the early part of the growing season, the surface should be kept as clean as a well cultivated corn field. But there should be no cultivation after the last of June, and in this latitude it will be better that cultivation stop two weeks earlier than this. Late cultivation encourages a late and immature growth, and we should try to get all growth well ripened, if we desire perfect fruitfulness. But it is not well to allow the orchard to grow up in weeds and grass. The surface, during fall and winter, should be covered with some leguminous crop. If the soil is clayey there is no better plant for this purpose than the annual or crimson clover. But we can get better results usually in the South by sowing cow peas in the orchard, as soon as cultivation ceases, and during the month of August sowing crimson clover all through the cow peas, letting both remain all winter, to be plowed under in April for the benefit of the trees.

Fertilizers for the Peach.

In common with all of our fruit trees, the peach needs an abundant supply of potash, and as some of the best soils for the peach are very deficient in this element it must be added artificially. But to make it effective, it should always be accompanied with a large supply of phosphoric acid. These forms of plant food are all that we need add, for by their aid we can get an abundant growth of

the legumes, and these will furnish all the nitrogen needed by the trees. The best forms in which we can get the fertilizers needed will be in the shape of acid phosphate and muriate of potash, using about six parts of the first to one part of the last, and adding about 300 to 500 pounds per acre, according to the needs of the soil.

Gathering the Crop.

Peaches are gathered for market as soon as matured and colored, and before any of the fruit has become soft. The best and most attractive form in which to ship them, is what are known as "Southern Carriers," or light crates, holding several small veneer baskets. The old plan of shipping in slatted bushel crates, is fast being superseded by the lighter and more attractive carriers, which not only put the fruit in the market in better shape, but are far more handy and attractive for the retail trade. The fruit must be carefully culled, rejecting all inferior fruit, and all soft specimens, no matter how fine. Remember that cullings in a package will sell the package, and not the fine fruit that may be mixed with them, and it is far better to feed the cullings to the pigs than to damage the sale by shipping them and paying freight on them.

The planting of the orchard should, in the first place, be made with the object of facilitating the gathering. Beginning with the earliest, plant in blocks all of one kind, so that in gathering the crop there will be no necessity for going over the same ground twice, but each block can be cleaned up as they mature, one after another. Neatness in packing, too, is a great help to sales. Trimming the boxes, with fancy-colored and stamped paper, always pays, as it shows that the shipper takes some pride in his fruit. Never allow a peach that has fallen to the ground to go into a package, but gather every specimen carefully by hand, and handle all as gently as you would an egg. Haul in spring wagons or on a tram-car from the orchard to the shipping point, and insist upon gentle handling at all points.

Varieties.

Do not plant too many sorts, particularly if the orchard is small. Have enough of each kind to make a good shipment, and avoid mixed lots that always sell for less. Under no circumstances put peaches of two or more kinds in the same package. Always mark plainly on the outside of the packages the kind of peach it contains. An attractive label in colors, with the name of the shipper and the variety, always help sales, as it shows that the shipper is not ashamed of his product.

Among the extra early peaches there is always much complaint of rot, and some sorts are almost worthless on this account. In this neighborhood, the Early Louise has rotted less than any of the extra earlies. Alexander has long been a standard extra early peach, but there are rumors of some that promise to supersede it. Do not

plant too many of the extra earlies, as they are soon superseded in the market by better sorts from further South. Among the early sorts coming just after the earliest, we have found the Mountain Rose, and Early York, among the best. Tillotson was formerly planted as an early, before the days of Louise and Beatrice, and we are inclined to believe it still superior to them. It is of small size, but usually colors very brightly, and has never rotted as the newer sorts. Following the early peaches, we find Mary's Choice a good peach, and then there is an abundance of good ones, such as Reeve's Favorite, Crawford's Early, Oldmixon Freestone, Crawford's Late, Elberta, Susquehanna (very large and fine, but a shy bearer), Ward's Late Free, Wilkin's Heath and Bilyeu's October. For northern shipment, in this latitude, we are of the opinion that it will not pay to plant any peach that ripens later than Crawford's Late or Elberta, for the market by that time is well supplied with fine peaches from the Maryland orchards. For canning purposes there is no better variety than Beer's Smock. This is a dry-fleshed yellow peach, that stands up in canning better than peaches of really better quality for eating out of hand.

Canning.

While we are of the opinion that any large enterprises in North Carolina at present are doomed to be unprofitable, until the fruit is produced here somewhat on the scale that it is grown in the peach district North, it is nevertheless certain that the canning of individual crops can be done with profit, if care is used to put a really good product on the market. Cans and attractive labels are so easily procured, that with a little study of the process on the part of the grower, he can put up his crop in such a shape so as to bring him perhaps more money than by shipping fresh and taking chances of glutted markets. Some of the most successful canning establishments in Maryland have started as individual enterprises for the purpose of canning only the product of the grower, and have developed into money-making concerns. In this way only would we at present advise any canning to be done. By buying the cans ready made and having an attractive label tithographed, and what is more important than all, putting up a sperior product, growers who are not located near enough to railroads to ship fresh, can make a business and gain a reputation for their goods that will enable them to extend their operations.

The Peach Belt of North Carolina.

At present we do not advise the extensive planting of peaches in the flat coast region, nor as as a rule in the lower Piedmont country. The sand hill country in Cumberland, Moore and Richmond counties seem to be the best peach belt of the State, but all the upper Piedmont country will furnish locations that are as good as any, if the low valleys and sunny slopes are avoided. And in many of the

mountain counties, beyond the Blue Ridge, there are locations where the crop will be a very certain one, and the quality of the product will be far better than that further east. The fruit-producing capacities of our mountain country have been so little developed that we are sure that, in the near future, the finest peaches will be produced somewhere west of the Blue Ridge, and along its eastern foothills.

Hillside Terraces or Ditches

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

BULLETIN NO. 121

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400

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HILLSIDE TERRACES OR DITCHES.

By F. E. EMERY, Agriculturist.

The proper handling of water on a farm is of very great importance. The value of an abundant supply of water to growing crops, and the injury produced by an excess, are often the controlling factors in crop production. Different methods of handling this water must be practised under the widely varying conditions which prevail in different sections, and with the very wide range of soils, and the topography of each. In general, on our hillsides where the soil particles are fine, great care must be given to ease down the rainfall in order to prevent the soil from being carried down with it, and thus produce unsightly galled and gullied areas, at once disheartening and expensive to reclaim. (See Plate 1.) Under-drains are suitable to some localities, but even with these, furrows are often necessary to hold the soil, when, as often happens, an inch or two of water may be poured down in a single shower or storm of longer duration.

Hillside ditches are often made, but they are soon fringed with an uncultivated weedy strip, harmful to the rest of the field, in addition to the waste of land and their unsightly appearance. They are also impassable to wagons and farm machinery which must be brought into more frequent use on North Carolina farms.

Confronted with the competition of recent years, and the necessity of adopting more intensive methods of farming with increasing use of farm machinery, Mr. P. D. Mangum, of Wake Forest, N. C., originated a method of terracing which has improved his land, and enabled him to use modern implements. After using the method for ten years since 1885, the result has been so satisfactory that it is being adopted and used by a large number of farmers who have visited his farm to inspect his "terraces" and learn how to construct them.

It may be safely stated that the popularity of these terraces is the pride of the town. This pride is well placed, too, for the water falling on fields well terraced, is so well handled that improvement begins at once. No water is allowed to "run" and begin to "cut" or denude any part of the field, and the grading is so evenly arranged that the soil water must always be moving through the soil, either with the slope of the hillside, or following the winding of the terrace toward the bottom in a more circuitous route. The terracing is done so that a plow, drill, reaper, rake, mower, or wagon can be driven safely over the field and the whole cultivated as

PLATE I.—Fields with incipient hillside washes, and deep gullies caused by incomplete ditching.

neatly as the most fastidious farmer might desire. Mr. Mangum's fields are patterns of clean culture, and the history of each one, under the new system, is one of increasing production with decreasing cost.

The observer may find the same kind of terracing in other localities and counties now (see Plate II), but nowhere else can there be found so enthusiastic an advocate as in the originator, who has seen his crops increase with the better provision for the distribution of rainfall, while the risk of serious damage from heavy showers and storms has diminished materially.

The method of making these terraces is, first to lay off a line rising from where the outlet of the terrace is to be, at an easy regular rate, so that the water will not run in the ditch or hollow which is prepared, and then plow out and finish with a level and hand tools.

The Leveling Instrument.

The Leveling Instrument (figure 1) will be first described, after which the construction of the terrace will be given. The instrument is a light, handy one, used in making the grade and locating the position of the terraces on the hillside. The most convenient instruments are such as have an even aliquot part of 100 feet for the spread of the legs or sides at the bottom. For convenience, the following description is for one which spans ten feet from outside to outside at the bottom. The wood must be light, well seasoned and straight, and free from tendency to warp. The legs should be cut on an angle of 45 degrees, and just 7 feet $\frac{8}{10}$ inch long on the out or longer side. When the cuts are joined evenly, the ends should rest on the ground or a floor, evenly, and just ten feet apart from outside to outside. The pieces may be 1 x 4 or 1 x 5 inches, dressed on four sides. A strip of wood to hold the top firmly together should be put on with screws. The cross bar should also be fastened with screws. It should be placed at the same distance from the top on each side so that it will be level when the instrument stands on a level floor. A saw cut in the top between the two sides will hold a plumb line, which, when the weight is attached and the instrument is set level, marks the middle point of the cross piece, if the measurements have been correctly made and the whole put together properly. Mark the middle point "0." Now, instead of using the

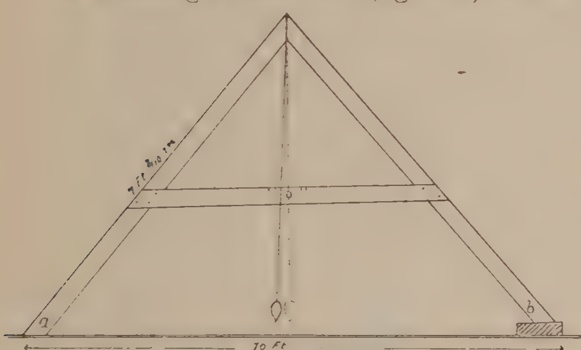

Fig. 1.—Levelling Instrument for laying out terraces.

PLATE II.—A Mangum Hillside Terrace on the farm of The N. C. College of Agriculture and Mechanic Arts. Crops are planted and cultivated upon the terrace.

plumb line for work, it is better, because wind affects the line, to use another device. Make a thin, light piece of wood, using, if desired, a piece cut from the cross-bar, or one of the legs, if it has length enough to reach from the top down over the cross-bar. Bolt it to the top of the instrument so that it will swing freely, observing to bore the bolt hole in the centre and also in the top of the instrument where the plumb line crossed it. When this tongue is bolted on, cut out a narrow opening in it just in front of the cross-bar so the "0" mark can be seen when the instrument stands level. A small iron carpenter's level, costing about 15 cents, can now be set into the tongue so the bubble in it will stand under the middle line when the instrument is on a level floor, and the "0" mark shows through the tongue when it hangs freely and at rest. Now it is ready to be graduated, i. e., to so place the marks by which it may be known how much fall is being given a terrace for every 100 feet of its length. Our instrument is ten feet wide, or just one-tenth of one hundred. If we raise one leg on a block one inch high it gives a rise of one inch in ten feet, which multiplied by ten gives ten inches for every one hundred feet. It may be best to make the graduations with a fine plumb line and quite a heavy weight. First fix the "0" mark accurately; then raise one leg on a two-inch block and mark the point where the line crosses the cross-bar with a fine pencil mark. Divide the space from "0" to the line into four equal ones By raising one leg two inches the high grade of 20 inches to 100 feet has been fixed. Dividing the space into four parts fixes a line on the bar for a grade of 5, 10, 15 and 20 inches per 100 feet, and these lines may be thus marked. A similar space on the opposite side of the "0" may be laid off and marked in the same way, and then either side may be used, or the other side may be graduated for different grades.

In cutting out the peep-hole on the tongue through which to see the "0" or grade mark, it will be well to observe the following precaution: Mark the middle of the tongue on both sides with a pencil for a space longer than the cross-bar is wide. Bore out a little of the middle of these lines in which to insert a small saw; then saw out the middle lines up and down to the width of the cross-bar or more. Bore more holes near the ends of the saw, cut and take out a round or oval piece of the tongue. Stretch a string across from saw cut to saw cut; or fit a thin, narrow, but straight piece of metal across the opening so it will cover the "0" line when the instrument stands level.

If desired, a larger instrument to span 12½ or any desired number of feet may be constructed in the same way. The width in feet should be made an even divisor of one hundred, which will save time in calculations, and be easier to use.

Laying off the Terrace.

In order to explain more easily the use of the level and grade of

a terrace, a drawing (figure 2) is here introduced. This represents a field which needs to be terraced. Dotted lines, called *contour lines*, have been drawn to show levels twenty inches apart vertically, that is, if one were to walk the whole length of one line he would neither go up nor down, but would go in and out on that level according to whether there were prominent places or hollows. Then if a twenty-inch rule were set up straight on one dotted line, its top would be just level with the next line above. By the crossing of the solid "terrace" lines over the dotted lines in the figure, one may see more plainly the progress which is being made. It is

Fig. 2.—A hill to be terraced, showing contour lines and location of terraces.

desired to direct the water toward the run on the left. The distance the terraces should be located from each other, depends on several conditions: the kind of soil, its depth and fineness, the steepness of the hillside, and the amount of rainfall which may be expected, rather than upon any fixed rules.

In figure 2, the lines of terraces have been run upward to the right from points a, b, c and d. This shows that starting with an instrument set to rise 10 inches for every 100 feet, the vertical distance between the contour lines is traversed in two hundred feet of the terrace. The water is carried off by each terrace in the simplest manner by making each one start at the points named above. If, however, it is desired to hold the water which falls on the land for a longer time, then when terrace a-g has been laid off, turn about and run up from "g" to "f-c," making a terrace "c-f-g," down which water must pass to reach the first terrace "g-a." In the

same way, starting again at "f" and laying off a terrace to "e" carries the water back down the hill in an easy zigzag direction, which allows for the greatest amount of soakage through the soil. No harm can be done at any point, because the grades, during the whole of their course, are so even that the water passes from point to point so gradually that its denuding effect is never felt.

After laying off a terrace and looking back over it, the stakes left to mark the course will be seen to be a very broken line. It will be well to go back over it and move in those too far out of the general curves on either side. It is good practice to take up the stakes to be used again, and the line of the terrace may be indicated by stiff broom straws, a handful of which is taken for the purpose when the line is to be evened up for the plow.

Forming the Terrace.

With a small plow and one mule turn two furrows, one up and the other down, on the line indicated by the broom straws. Now a heavier plow and team may be used and eight or ten furrows plowed on each side toward the first, which is to be the embankment of the terrace when completed. The work may now be advanced by plowing on the upper side only, as shown by the drawings* (see figure 3), except that more earth will be removed in this case than is there shown, and the bank made higher when the terrace is finished. A side-hill plow to work back and forth on the same strip should be used, but turning the soil every time one fur-

Fig. 3.—Process of forming Terraces by the use of the plow.

row toward the bank of the terrace. When the plow has been used as much as is desirable, the work may be finished by hand labor. Use a level, and shovel out enough of the plowed soil from the upper side on to the bank to make a level about ten feet wide. (See "c," figure 4). The terrace is complete when this leveling has been

*From N. C. Experiment Station Bulletin 71.

done. The terrace is kept up and strengthened each year by making the bank the back furrow every time the field is plowed.

In planting, the rows are run diagonally across each terrace and just steep enough, so that if there is any water to run it will follow the row instead of crossing from row to row. Water is discharged from row to terrace toward the top, or up hill rather than down. Therefore the steepness of the hillside, and tendency of the soil to

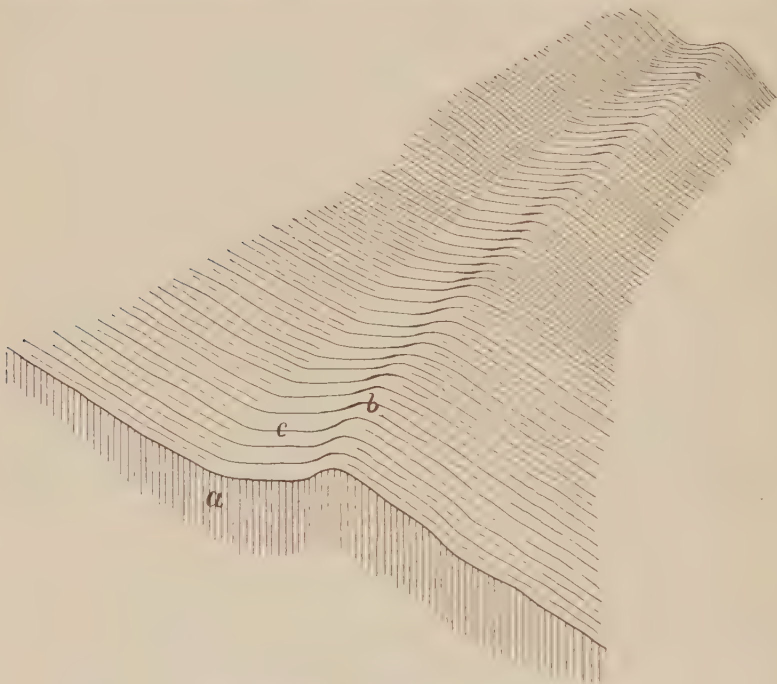

Fig. 4.—Section of Hillside showing Terrace.

wash, determines the slope of the rows. The tendency all the time should be to deepen the soil by thoroughness in plowing, and thus further retard the flow of water. Care should be taken to add something to the humus in the soil each year, and also to plow a little deeper each time until there is a sufficient depth of soil to take up and hold the water from a sudden heavy shower or a long storm, and ease it down to the outlets of the terraces with no appearance of water on the surface to threaten a break anywhere in the field.

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No. 119. Volumetric Estimation of Phosphoric Acid, pp. 24. (A technical bulletin.)
No. 120. Cultivation of the Peach Tree, cuts 22, pp 36.

Types of Tobacco

and their Analyses

ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

BULLETIN NO. 122

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RALEIGH, N. C.

TYPES OF TOBACCO, AND THEIR ANALYSES.*

By F. B. Carpenter, Assistant Chemist.

1. INTRODUCTION.

The cultivation of tobacco in the United States as an article of commerce, was first commenced by the English colonists who settled in Virginia. The plant was found in cultivation by the natives, when the Albemarle sound region was first explored by the English expedition in 1584, under the auspices of Sir Walter Raleigh, but the first general planting of tobacco on a commercial scale did not begin until 1616, when the Virginia colony consisted of about 350 persons. Its cultivation increased with the growth of the colony and very soon became one of the most important articles of trade. From this small beginning, the cultivation of tobacco has gradually become more general, until at the present time it is produced to greater or less extent in forty-two states and territories. According to the eleventh census, "The entire crop of the country in 1889 amounted to 488,255,896 pounds, the number of planters being 205,-862, and the area devoted to tobacco culture, exclusive of counties cultivating less than one acre, 692,990 acres, or 1,082.80 square miles. The area in cultivation was, however, very unequally distributed. Kentucky having 39.62 per cent. of the total acreage and producing 45.44 per cent. of the entire crop, and the six states next in rank of production 50.16 per cent. of the acreage and 42.49 per cent. of the crop, while the twenty states and territories having the smallest production had less than 900 acres in tobacco and yielded an aggregate of only 451,025 pounds, or less than one-tenth of one per cent. of the entire crop. The average production per acre of the entire country was 705 pounds, ranging among the seed-leaf states, producing 5,000,000 pounds or upward, from 854 pounds per acre in Ohio to 1,402 pounds per acre in Connecticut, and in the more important of the states in which the manufacturing and export varieties predominate, from 375 pounds per acre in North Carolina, to 830 pounds per acre in Missouri. The total value of the crop to the producers, estimated on the basis of actual sales, was $34,844,449, an average of 7.1 cents per pound or $50.28 per acre. The average price per pound received by the producer in states producing 5,000,000 pounds or upward ranged from 4.5 cents in Missouri and 4.7 cents in Maryland to 12.8 cents in Connecticut and 14.2 cents in North

*For table of contents, see last page.

Carolina. The product in Louisiana averaged 25.2 cents per pound to the producer." Thus in taking a general survey of the tobacco industry of the United States, while the crop is produced to some extent in nearly every state from the Atlantic to the Pacific, we find that the main bulk is still produced east of the Mississippi, in a section which radiates from the point where the first settlers began the cultivation of the crop nearly 300 years ago. While this is due, in a great measure, to the gradual extension of the industry from its initial point, the cultivation has generally been undertaken in those sections where the natural conditions are favorable for more profitable returns than those of other crops. It is probable, also, that there are other sections in the United States as favorable for the production of the crop as some localities where it is now extensively grown

While the cultivation of tobacco is not as general or extensive as that of the principal food products, nor is it essential that it should be, yet it forms a very important branch of agricultural industry of certain sections of this country, and is deserving of the attention which its importance merits. None of the other large agricultural crops require such careful and intelligent culture; none yields so readily to the varying influences of climate, soils, fertilizers, cultivation, harvesting and curing; and there is scarcely another farm product the money value of which is enhanced to such a degree, by a practical and intelligent knowledge of these agencies. A thorough knowledge of the various conditions necessary for attaining the best results should require, in addition to the elements and forces of production, information concerning the nature and composition of the plant itself.

In the present bulletin is given partial analyses of carefully selected tobaccos grown in the principal tobacco sections of the United States. These analyses are supplemented with such facts, gleaned from personal observation, together with information of a general nature, established by repeated investigations, as would be of interest and value to those who study the tobacco industry in all its bearings.

2. PRODUCTION OF TOBACCO IN THE UNITED STATES.

The following table, compiled by the eleventh census for the year 1889, gives a very complete resumé of the production of tobacco in the United States, omitting those states and territories producing less than a crop of 100,000 pounds per year, where the crop is not of commercial importance.

TABLE I.—SUMMARY OF STATISTICS OF TOBACCO PRODUCTION, IN STATES PRODUCING IN 1889 MORE THAN 100,000 POUNDS.

STATES AND TERRITORIES.	Number of planters.	Area. in Acres.	Crop. in Pounds.	Value.	Av. yield per acre. in Pounds.
The United States	205,862	692,990	488,255,896	$34,844,449	705
Alabama	3,556	679	162,430	17,173	239
Arkansas	5,448	1,875	954,640	89,862	509
Connecticut	2,815	6 331	8,874,924	1,132,111	1,402
Florida	632	1,190	470,443	105 891	395
Georgia	2,299	800	263,752	28,556	329
Illinois	2,499	4,155	3,042,936	116,340	732
Indiana	4,457	9,373	7,710,297	384,370	823
Kentucky	61,641	274 587	221,880,303	13,155,297	808
Louisiana	120	109	46,845	11,797	427
Maryland	3,108	17,966	12,356,838	579,689	688
Massachusetts	786	2,012	2,794,848	339,074	1,389
Missouri	10,495	11,350	9,424,823	419,520	830
New York	3,532	8 629	9,316,135	836,067	1,080
North Carolina	27,250	97,077	36,375,258	5,175,833	375
Ohio	12,929	44,303	37,853,563	2,642,858	854
Pennsylvania	10,365	26,955	28,956,247	1,984,754	1,074
South Carolina	585	394	222,898	33,908	566
Tennessee	16,624	51,471	36,368,395	1,841,464	707
Texas	1,861	423	175,706	15,131	415
Virginia	24,034	110,579	48,522,655	4,323,649	439
West Virginia	3,794	4,647	2,602,021	302,380	560
Wisconsin	4,124	17,241	19,389 166	1,260,565	1,125

3. VARIETIES AND CLASSIFICATION OF TOBACCOS.

The long continued cultivation of the tobacco plant, together with the great variations in soil and climate found in its extensive and widespread cultivation, has produced a great number of local varieties, which have often been mistaken for distinct species. There are at the present time more than 100 differently named tobaccos grown in the United States, many of which are only synonomous, or appellations descriptive of different peculiarities of the same variety. These local designations are generally recognized by growers, and the true botanical classification has become somewhat obscure.

The following list, taken from the seed catalogue of R. L. Ragland Seed Co., gives the names of some of the newer and standard varieties of the different classes of tobacco grown in the United States at the present time:

Varieties of bright and mahogany manufacturing leaf.

Ragland's Conqueror.
Bonanza.
Safrano.
Gold Finder.
Bullion.
Climax.
Ragland's Improved Yellow Oronoko.
Ragland's Improved Yellow Pryor.
Oak Hill Yellow.
Ragland's Improved White Burley.
Honduras.
Premium.
Famous.
Red Burley.
Sterling.
Long-leaf Gooch.

Granville County Yellow.
Tuckahoe.
White Stem Oronoko.
Hyco.
Hester.
Yellow Oronoko.
Gooch.
Bradley Broad-leaf.
Yellow Pryor.
Blue Pryor.
Sweet Oronoko.
Flanagan.
Little Oronoko.
One Sucker.

Varieties of dark rich export leaf.

Lacks.
Yellow Mammoth.
Tennessee Red.
Clardy.
Kentucky Yellow.

Varieties of cigar tobacco.

Vuelta de Abajo.
Choice Havana.
Havana Seed Leaf.
Pumpelly.
Comstock Spanish.
Sumatra.
Gen. Grant.
Brazilian.
Cuban Seed Leaf.
Connecticut Seed Leaf.
Pennsylvania Seed Leaf.
Evans or Cinnamon Scented.
Big Havana.

On account of the existing confusion of the names of the different varieties and modifications produced by different soils and climates, this classification is of little value for purposes of commerce. Different countries have somewhat different systems of classification, but in the United States the trade recognizes class, type, and grade. Under the head of *class* is included each group which is adapted to a certain purpose, for example, the seed-leaf varieties come under one class, because they are all used for cigars and smokers. By *type* is meant the combinations of certain qualities and properties in the leaf, as color, strength, elasticity, flavor, body, etc., or to certain characteristics produced by certain methods of curing, as sun-cured, flue-cured, air-cured, etc. *Grades* represent the different degrees of quality in a type, as wrappers, binders, fillers, good, medium, low, etc. Different tobaccos vary very much in respect to their possible classification. One type may comprise one or more classes, or one district may produce several types of the same class, for example the fine yellow tobacco grown in the so-called golden-belt district of North Carolina, is a distinct type, and yet is used for both smoking and chewing purposes, and is therefore placed in two classes. There are also several types of the fine seed-leaf tobacco, and yet they are used for a similar purpose, and hence are placed in one class. The various types are usually confined to certain sections favorable for the development of certain qualities which give the leaf a distinct characteristic.

The following group arrangement, taken from the tenth census, very nearly represents the trade classification as it now exists. In this schedule of classification, no attempt is made to divide into separate classes that portion of the crop taken for exportation. All this is thrown together in one class, called export tobacco, though the types suited for different countries are given.

Classes, Types, and Sub-Types.

Class I.—Domestic Cigar Tobacco and Smokers.

Seed-leaf and Havana Seed.

Connecticut Seed-Leaf.
New England Seed-Leaf.
Pennsylvania Seed-Leaf.
New York Seed-Leaf.
Ohio Seed-Leaf.
Wisconsin and Illinois Seed-Leaf.
Florida Seed-Leaf.

Other Cigar and Smoking Tobacco.

White Burley Lugs.
American-grown Havana.
Perique.
Common Virginia, North Carolina, Missouri, East Ohio, Maryland, Tennessee, Kentucky, Indiana and Illinois lugs.
Kentucky and Indiana cheroot and stogie wrappers and fillers.
Fine-fibered Clarksville wrappers.
Indiana Kite-Foot.

Class II.—Chewing Tobacco.

Fine-cut and Plug Fillers.

Fine-cut Burley.
Fine-cut Mason county.
White Burley fillers.
Red Burley fillers.
Virginia sun and air-cured fillers.
Tennessee and Kentucky air-cured fillers.
Virginia flue cured fillers.
Missouri air-cured fillers.
Kentucky, Indiana, Tennessee, Virginia, Maryland and West Virginia fire-cured fillers.

Plug Wrappers.

Virginia yellow and mahogany.
North Carolina yellow and mahogany.
Western Kentucky yellow.
Hart county (Ky.) bright and yellow.
Henry county (Tenn.) yellow.
Missouri and Arkansas yellow.
West Virginia yellow.
Clarksville and Missouri dark and red.
Mason county (Ky.) Burley.

Class III.—Export Tobacco.

English Shippers.

Bird's-eye cutting leaf.
Brown roll wrapper.
Spinning leaf.
Shag—a heavy cutter.
Plug wrapper.
Plug fillers.
Navy leaf.
Irish filler.
Scotch Elder.
Scotch and Irish spinners.
Strips—used for same purpose, as above.

Continental Shippers.

French Regie—A, B, and C.
Italian Regie—A, B, and C.
Austrian Regie.
Spanish Regie.
Snuff-leaf and lugs.
Germany:
  German saucer.
  German spinner.
  Ohio, Maryland, and West Virginia
    Spangled.
    Smokers—fat lugs.
Switzerland:
  Swiss wrappers.
  Swiss fillers.
Holland:
  Dutch saucer.
Belgium:
  Belgian cutter.
Denmark, Norway, and Sweden:
  Heavy Kentucky and Tennessee types.

African Shippers.

Liverpool African.
Boston African.
Gibralter African.

Mexico, South America, and West Indies.

Baling wrapper.
Baling filler.

In table II (pages 338–343) will be found further information concerning the tobacco industry, as it exists in some of the principal tobacco sections in the United States. These facts were obtained from expert growers and dealers by Dr. H. B Battle, to illustrate such samples of tobacco as were collected and exhibited under his supervision at the World's Columbian Exposition in 1893. While all the different districts are not represented in these tables, we have nearly all of the principal types that are used for domestic and export trade, and a good general idea can be obtained concerning the nature of the soils and the amount and kind of fertilizers used in the different sections, together with the character and amount of the resulting crop. It also gives the usual market price of the different varieties, together with the different trades supplied, and the products into which they are manufactured. These facts, together with the resulting composition of some of the typical varieties, form a valuable aid in drawing conclusions concerning the various requirements necessary for obtaining the most profitable results in the various sections. More detailed descriptions of the various tobaccos are inserted under the heading "The Composition of Various Tobaccos."

4. TOBACCO SOILS.

The success or failure in growing a certain type of tobacco depends to a great extent upon the character of the soil. While one soil may produce an excellent quality of a certain variety, it may be wholly unfitted for the growth of another variety, which will attain its characteristic qualities on different lands. Notwithstanding this fact, it may be said that tobacco will grow upon almost any soil where other agricultural crops will thrive, yet there is no other crop whose general appearance, quality, and composition is so readily affected by the different conditions of soils and by the nature and amount of the various fertilizers. While it will readily adapt itself to the diverse conditions of soil and climate, each distinct type requires certain conditions to best develop those characteristic qualities in the leaf which are most highly prized. It has been stated that the finer qualities are restricted to certain limits defined by characteristic geological peculiarities; while it is more or less true that each distinct soil formation gives peculiar qualities to the plant as to texture, color, flavor, and general structure, it cannot be said that the best qualities are developed by any single formation. In looking over the tobacco-growing sections of the United States we find nearly all of the principal geological outcrops represented, but some cover much more extensive areas than others, chief among these being the Carboniferous period of the Paleozoic era. This is the chief outcrop in the tobacco districts of Missouri, Tennessee, Arkansas, western Kentucky, Indiana, southern Illinois, West Virginia and eastern Ohio, and the principal types grown in these localities are the heavy shipping varieties. The same era is represented by the Silurian period in northeast Kentucky, southwest Ohio, Wisconsin, northern Illinois, and northern New York. The next largest outcrop is that of

the Archæan period, upon which are grown the fine bright varieties of Virginia and North Carolina. The seed leaf varieties seem to be confined chiefly to soils formed from disintegration of rocks of the Silurian, Devonian, Triassic, and Archæan periods. These with other formations are accompanied with soils of varying composition and character.

It is generally understood that light colored soils produce light tobacco, and dark soils produce dark tobacco. While this statement is most generally true, it must be understood that the characteristic coloring is also due to the condition and texture of the soil and the composition of the fertilizers, as well as to any particular color the soil may possess. While the seed-leaf varieties will produce a finer leaf on light sandy lands, the demand in recent years has been for darker colors as best suited for cigar wrappers, and the colors most in fashion are grown upon highly fertilized argillaceous and calcareous loams. The fine yellow type of North Carolina and Virginia are grown upon light-gray sandy soils. While certain lands are adapted to certain types of tobacco, there are certain characteristic features which are essential in developing the best qualities of any variety. Climate, undoubtedly, has much to do in producing the fine aromatic flavor upon which the value largely depends, but with present knowledge, we are unable to trace the relation existing between the various climatic influences, and the formation of desirable qualities in the plant. It has been observed, however, that the production of the finest flavored tobaccos is usually accompanied by the agencies of high temperature and moisture. The relations of soils in this connection have been better studied. Of first importance, for the development of a fine leaf of any variety, is a well drained soil in good physical condition. These two requirements are really of more importance than the chemical composition, for a soil destitute of the proper elements of plant food can have them supplied by the judicious application of proper fertilizing materials, but good results cannot be obtained on wet or coarse lands. The soil best suited for a fine smoking tobacco is a light sand or sandy loam. As a rule the larger the percentage of sand, the finer and more silky is the texture of the leaf. This is admirably illustrated in case of the bright yellow tobacco grown in Granville county, North Carolina, where the soil in some cases contains over ninety-five per cent. sand. The application of large quantities of organic matter in the shape of stable manures, etc., gives a very large return, but usually of a somewhat inferior quality. The presence of considerable amounts of clay in the soil has a tendency to increase the yield but the quality will be inferior, the leaf being coarser and heavier and lacking in proper flavor. Clay soils may, however, if properly loosened by the application of humus, and suitably cultivated, produce profitable crops of certain types; in fact almost any well drained fertile soil, by proper tillage and judicious manuring, may at least be made to grow good crops of the lower grades, which may be profitable in some sections of the country.

TABLE II.—DESCRIPTION OF TOBACCO GROWN IN

Where grown.	Name and address of sender.	Variety.	For what trade.	In what form manufactured.	Average value per pound.
Connecticut, Hartford Co	E. N. Phelps, Windsor, Conn.	Havana seed leaf.	Domestic	Cigar wrappers.	50 cents
Connecticut, Hartford Co	H. H. Austin, Suffield, Conn.	Havana seed leaf.	Cigar	Cigar wrappers.	50 cents
Canneticut, Hartford Co	H. S. Frye, Poquonaock, Conn.	Havana seed leaf.	Cigar	Exclusively for cigars.	25 cents
Connecticut, Bancroft Co	E. N. Phelps, Windsor, Conn.	Havana seed leaf.	Domestic	Cigar wrappers.	50 cents
Florida, Columbia Co	F. B. Moodie, Lake City, Fla.	Cigar leaf wrapper.	Sold in Cincinnati, New York and New England.	Wrappers and fillers.	Wrappers $2 to $4; fillers less.
Kentucky, Davess Co	W. Clark & Co Owensboro, Ky.	London strips.	English	"Shag"	9 pence in London.
Kentucky, Davess Co	W. Clark & Co Owensboro, Ky.	English leaf.	English	Cut into form similar to fine cut.	8 pence in London.
Kentucky, Bracken Co	G. M. Coyce, Cincinnati, Ohio.	Kentucky white Burley.	Domestic and foreign.	Plug, fine cut and smoking.	10 cents
Kentucky, Graves Co	J. T. Wright, Paducah, Ky.	German shipping tobacco.	Bremen	Spinning and cigar wrappers.	8½ cents
Massachusetts, Hampshire Co	Frank Scott, N. Hadley, Mass.	Wilson's Hybrid Havana.	Cigar	Cigar wrappers.	15 to 25 cents
Massachusetts, Hampshire Co	Jacob Carl, Hatfield. Mass	Havana seed leaf.			20 cents
New York, Onondaga Co	W. Tappan, Baldwinsville, N. Y.	Wilson's Hybrid Havana.	Cigar	Wrappers, binders and fillers.	Wrappers 30 cts; binders 12 cts; fillers 7 cents.
New York, Onondaga Co	W. Tappan, Baldwinsville, N. Y.	Domestic Havana eureka.	Cigar	Wrappers, binders and fillers.	Wrappers 30 cts; binders 12 cts; fillers 7 cents.
North Carolina, Alamance Co	C. A. Bray & Co., Burlington, N. C.	Fancy English strips.	English manufacture.	Plug	45 cents, raw values.
North Carolina, Wake Co	E. L. Flemming, Raleigh, N. C.	Lemon wrapper.	American	Wrapping fine grades of plug.	50 to 75 cents.
North Carolina. Wake Co	E. L. Flemming, Raleigh, N. C.	Mahogany wrapper.	American	Wrapping fine grades of plug.	50 to 75 cents.
North Carolina, Wake Co	E. L. Flemming, Raleigh, N. C.	Cutter.	American	Cigarettes	27 to 30 cents.
North Carolina, Wake Co	E. L. Flemming, Baleigh, N. C.	Fine smoker.	American	Granulated smoking.	15 cents
Ohio, Miami Co	Allen & Wheeler, Troy, Ohio.	Ohio seed leaf.	Cigar	Binders' fillers and wrappers.	8 cents
Ohio, Miami Co	Allen & Wheeler, Troy, Ohio.	Little Dutch.	Cigar	Cigar fillers	13 cents
Ohio, Miami Co	Allen & Wheeler, Troy, Ohio.	Zimmer Spanish.	Cigar	Fillers and binders.	11 cents
Ohio, Highland Co	Frank Austin, Hillsboro, Ohio.	Large white Burley.	Cincinnati and Louisville.	Fine cut chewing.	18 to 20 cents.
Ohio, Highland Co	Frank Austin, Hillsboro, Ohio.	Good red leaf of white Burley.	Cincinnati and Louisville.	Plug	18 to 20 cents
Ohio, Highland Co.	Frank Austin, Hillsboro, Ohio.	Good bright leaf.	Cincinnati and Louisville.	Plug and fine cut.	20 to 25 cents
Ohio, Montgomery Co	C. F. Steinkamp, Cincinnati, O.	Little Dutch filler.	Cigar	Cigar fillers	8 to 9 cents

DIFFERENT PARTS OF THE UNITED STATES.

Average yield per acre.	Character of soil.	Kind and amount of fertilizers applied per acre.	Does land depreciate with continued cropping?	Average value of tobacco lands per acre.
1800 pounds ----	Sandy loam-----	Cotton seed meal 2000 lbs. and cotton hull ashes 1200 lbs.	No -------------------	$150 to $200.
1800 pounds ----	Light loam------	600 lbs. sul. potash, 1 ton cotton seed meal, 400 lbs. ground bone and 300 lbs. lime—broadcast.	No, it improves------	$200.
1800 pounds ----	Sandy loam-----	1500 lbs. cotton seed meal, 500 lbs. castor pomace, 1000 lbs. cotton hull ashes, 800 lbs. bone phos.	No, with proper fertilization.	$100.
1800 pounds ----	Sandy loam-----	Cotton seed meal 2000 lbs. and cotton hull ashes 1200 lbs.	No -------------------	$150 to $200.
500 to 1000 lbs ---	Light sandy loam.	On new hammock none, on old land 200 to 2000 lbs. mixed fertilizer.	No, if rotation of crops is practiced.	$3 to $30.
1000 pounds-----	Clay loam and sandy loam.	None------------------------------	Yes, after three years from clearing.	$25 to $100.
1000 pounds-----	Clay loam and sandy loam.	None------------------------------	Yes, after three years from clearing.	$25 to $100.
1000 pounds-----	Limestone-------	None------------------------------	Yes-------------------	$50
800 pounds------	Clayey loam-----	None------------------------------	Yes-------------------	$15.
1400 to 1800 lbs--	Light sandy loam.	Sul. potash 600 lbs., dry fish 1000 lbs., cotton seed meal 1000 lbs., and barnyard manure 6 cords.	No, it improves------	$200.
1600 pounds-----	Sandy loam-----	Cotton seed meal 2000 lbs. and sul. potash 500 lbs.	No -------------------	$200.
1000 to 1200 lbs--	Sandy, gravelly loam.	Barnyard manure, ashes, cotton seed meal, plaster, etc., say 500 lbs. commercial fertilizer.	No, with proper fertilization.	$50 to $250.
Average 1100 lbs	Sandy and gravelly loam.	Barnyard manure, ashes, cotton seed meal, plaster, etc., say 500 lbs. commercial fertilizer.	No, with proper fertilization.	$50 to $250.
100 lbs. of this grade with 400 lbs. poorer grade	Sandy sub-soil.	400 lbs. ammoniated fertilizer---	Yes-------------------	$10.
500 to 600 lbs----	Light sandy-----	------------------------------	-------------------	-----------
600 to 700 lbs----	------------------	------------------------------	-------------------	-----------
500 pounds------	Light gray with yellow subsoil.	400 to 500 lbs. ammoniated fertilizer for tobacco.	Yes-------------------	$15 to $40.
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1200 pounds-----	Sugar tree soil, clay.	Manure----------------------------	Yes-------------------	$75.
About 800 lbs---	Sugar tree lands.	Manure----------------------------	Yes, not over two crops in succession.	$75.
900 pounds------	Bottom lands---	Manure----------------------------	Yes-------------------	$75.
1800 to 2000 lbs., including all grades.	Rich limestone soil.	This was grown in old house lot.	No, if well manured yearly.	$50 to $75.
1800 to 2000 lbs., including all grades.	Rich limestone soil.	This was grown in old house lot.	No, if well manured yearly.	$50 to $75.
1800 to 2000 lbs., including all grades.	Rich limestone soil.	This was grown in old house lot.	No, if well manured yearly.	$50 to $75.
900 pounds------	Red clay is best adapted and produces best quality and flavor.	Clover sod and stable manure preferred.	Yes, unless liberally manured with stable manure each year.	$100.

TABLE II.—(CONTINUED)—DESCRIPTION OF TOBACCO GROWN IN

Where grown.	Name and address of sender.	Variety.	For what trade.	In what form manufactured.	Average value per pound.
Ohio, Montgomery Co	C. F. Steinkamp, Cincinnati, O.	Ohio seed leaf wrapper.	Cigar	Cigars	About 6 cents to raiser.
Ohio, Montgomery Co	C. F. Steinkamp, Cincinnati, O.	Zimmer Spanish filler.	Cigar	Cigar fillers	About 9 cents to raiser.
Ohio, Belmont Co	Howard & Reid, Barnesville, Ohio.	White Burley air-cured.	Home consumption.	Chewing	7 cents
Ohio. Belmont Co	Howard & Reid, Barnesville, Ohio.	White Burley fire cured.	European		10 cents
Tennessee, Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	French B.	France	Cigars and smoking tobacco.	6½ to 7 cents
Tennessee, Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	Italian B.	Italy	Cigars	7 to 7½ cents
Tennessee, Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	Austrian B.	Austria	Cigars	9 to 11 cents
Tennessee. Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	Stemming leaf for English strips.	Great Britian	Twist for chewing and cut for pipe.	5½ to 7 cents
Tennessee, Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	European cigar wrapper.	Germany, Switzerland and Austria.	Cigars	10 to 13 cents
Tennessee, Montgomery Co	M. H. Clark & Bro. Clarksville, Tenn.	German filler	Germany, Norway and Sweden.	Twist for chewing.	6 to 6½ cents
Tennessee, Montgomery Co	M.H.Clark & Bro. Clarksville, Tenn.	German spinning leaf.	Germany, Norway and Sweden.	Twist for chewing.	7½ to 11 cents
Tennessee, Montgomery Co	B. K. Gold, Clarksville, Tenn.	Austrian wrapper.	Austria	Cigar wrapper.	11 cents
Tennessee, Montgomery Co	B. K. Gold, Clarksville, Tenn.	Dark wrapper.	United States.	Plug	12 cents
Tennessee, Montgomery Co	B. K. Gold, Clarksville, Tenn.	Italian style.	Italian	Cigars and snuff.	7½ cents
Tennessee, Montgomery Co	B. K. Gold, Clarksville, Tenn.	German spinner.	German	Twist for chewing.	9 cents
Tennessee, Montgomery Co	B. K. Gold, Clarksville, Tenn.	French style.	France	Cigars and cigarettes.	6½ cents
Virginia, Henrico Co	E. O. Notting & Co., Richmond, Va.	French Regie snuff leaf.	French Regie	Snuff	7 cents
Virginia, Henrico Co.	E. O. Notting & Co., Richmond, Va.	Italian Regie cigar wrapper.	Italian Regie	Cigars	14 cents
Virginia, Henrico Co	E. O. Notting & Co., Richmond, Va.	Austrian Regie cigar wrapper.	Austrian Regie	Cigars	14 to 16 cents
Virginia, Henrico Co	E. O. Notting & Co., Richmond, Va.	Italian Regie cigar filler.	Italian Regie	Cigars	10 cents
Virginia, Henrico Co	E. O. Notting & Co., Richmond, Va.	Austrian Regie cigar filler.	Austrian Regie	Cigars	13½ cents
Virginia, Henrico Co	E. O. Notting & Co., Richmond, Va.	Bremen Saucers.	Chiefly Norway	Twist and smoking.	12 cents
Virginia, Dinwiddie Co	Vaughan, Hill & Co, Petersburg. Va.	Large dark wrapper.	Domestic and export.	Plug	18 cents
Virginia, Dinwiddie Co	Vaughan, Hill & Co. Petereburg, Va.	Small dark wrapper.	Principally export.	Plug and twist.	11 to 12½ cents
Virginia, Dinwiddie Co	Vaughan, Hill & Co. Petersburg, Va.	Austrian wrapper.	Austria, Italy and other countries where dark tobaccos are used.	Plug and cigars.	15 to 18 cents

DIFFERENT PARTS OF THE UNITED STATES.

Average yield per acre.	Character of soil.	Kind and amount of fertilizers applied per acre.	Does land depreciate with continued cropping?	Average value of tobacco lands per acre.
1200 pounds	Black sandy loam preferred	Clover sod with 4 to 8 tons stable manure preferred.	Yes, unless liberally manured with stable manure each year.	$100.
800 pounds	Red clay is best suited and produces best qu'lity	Stable manure and other fertilizers are used in a very limited way.	Yes, without the use of fertilizers.	$100.
1000 pounds	Dark sandy loam.		Yes	$40.
1000 pounds	Sandy loam, new ground.	None on new land.	Yes	$40.
800 to 900 lbs	Thinned clay limestone foundation.	Stable manure according to supply and need.	Yes, except by rotation of crops.	$10 to $20.
900 to 1200 lbs	Red clay with limestone foundation.	Stable manure and commercial fertilizer.	Yes, except by rotation of crops.	$20 to $30.
900 to 1100 lbs	Red clay with limestone foundation.	Stable manure according to supply and need.	Yes, except by rotation of crops.	$20 to $30.
1000 to 1300 lbs	Red clay with limestone foundation.	Stable manure with about 200 lbs. commercial fertilizer.	Yes, except by rotation of crops.	$15 to $30.
1000 to 1200 lbs	Deep red clay with limestone foundation.	Stable manure with about 200 lbs. commercial fertilizer.	Yes, except by rotation of crops.	$20 to $40.
1000 to 1200 lbs	Red clay with limestone foundation.	Stable manure according to supply and need.	Yes, except by rotatiou of crops,	
1000 to 1200 lbs	Red clay with limestone foundation.	Stable manure according to supply and need.	Yes, except by rotation of crops.	$25 to $40.
1000 pounds	Limestone	Tobacco grower, about 75 lbs. per acre.	Yes	$30 to $40.
1000 pounds	Limestone	Tobacco grower, about 50 to 75 lbs. per acre.	Yes	$30 to $40.
800 pounds	Limestone	Tobacco grower, 50 to 75 lbs. per acre.	Yes	$30 to $40.
900 pounds	Limestone	Tobacco grower, 50 to 75 lbs. per acre.	Yes	$30 to $40.
700 pounds	Limestone	Tobacco grower, 50 to 75 lbs. per acre.	Yes	$30 to $40.
550 pounds	Clay	600 pounds sundries	Yes	$5.
800 to 1000 lbs	Clay	600 pounds sundries	Yes	$5.
800 to 1000 lbs	Clay	600 pounds sundries	Yes	$5.
800 to 1000 lbs	Clay	600 pounds sundries	Yes	$5.
800 to 1000 lbs	Clay	600 pounds sundries	Yes	$5.
500 to 600 lbs	Sandy and heavy.	600 pounds sundries	Yes	$5.
1200 to 1500 lbs., whole crop.	Red or gray with clay subsoil.	Stable manure with some commercial fertilizer.	Not with intelligent farming.	$8 to $10.
1000 lbs., whole crop.	Red or gray with clay subsoil.	Stable manure with some commercial fertilizer.	Not with intelligent farming.	$8 to $10.
1200 to 1500 lbs., whole crop.	Red or gray with clay subsoil.	Stable manure with some commercial fertilizer.	Not with intelligent farming.	$8 to $10.

TABLE II.—(CONCLUDED).—DESCRIPTION OF TOBACCO GROWN IN

Where grown.	Name and address of sender.	Variety.	For what trade.	In what form manufactured.	Average value per pound.
Virginia, Dinwiddie Co	Vaughan, Hill & Co. Petersburg, Va.	Fine Australian filler.	Australia and other countries.	Plug	8 to 10 cents
Virginia, Pittsylvania Co	Schoolfield & Watson, Danville, Va.	Fine dark Virginia filler.		Fillers for plug and twist.	12½ cents
Virginia, Pittsylvania Co	Schoolfield & Watson, Danville, Va.	Fine bright Virginia filler.		Plug, twist, fine cut and plug cut.	About 12 cents
Virginia Pittsylvania Co	Schoolfield & Watson, Danville, Va.	Fine bright Virginia wrapper.		Wrap'ng fine bright plug and twist.	45 to 65 cents
Virginia, Pittsylvania Co	Schoolfield & Watson, Danville, Va,	Fine bright mahogany wrapper.		Wrap'ng fine bright plug and twist.	25 to 40 cents
Virginia, Pittsylvania Co	Pemberton & Penn, Danville, Va.	Bright export.	English	Cigarette and smoking.	15 cents
Virginia, Pittsylvania Co	E. B. & C. W. Guewont, Danville, Va.	Export bright strips.	English	Chewing and smoking.	18 cents
Virginia, Pittsylvania Co	E. B. & C. W. Guewont, Danville, Va.	Export bright cutters.	England and other countries.	Cigarette and smoking.	16 cents
Virginia, Charlotte Co	Dibrell Bros., Danville, Va.	Cutting lug.	Canadian	Smoking	7 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va	Bright wrapping leaf.	English	Smoking	25 cents
Virginia, Charlotte Co	Dibrell Bros., Danville, Va.	Common filler.	Domestic	Chewing	6 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Canadian filler.	Canadian	Smoking plug.	10 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Fine cigarette cutter.	English	Cigarettes	24 cents in strips; 16 cents in leaf.
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Wrapper strips.	English	Smoking	30 cents in strips; 20 cents in leaf.
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Medium bright wrapper.	Domestic	Plug	20 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	English strip.	English	Cigarettes	16⅔ cts. in strips; 11½ cts. in leaf.
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Fine bright wrapper.	Domestic	Plug	30 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	Cutting lug.	Domestic	Cigarettes	12 cents
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	English strip.	English	Smoking	9 cts. in strips; 6 cts. in leaf.
Virginia, Pittsylvania Co	Dibrell Bros., Danville, Va.	English strip.	English	Cigarettes	16⅔ cts. in strips; 11 cts. in leaf.
Pennsylvania.	Aug. Pollock, Wheeling, W. Va.	Pennsylvania seed leaf.	Cigar	Cigar fillers and wrappers.	Wrappers 20 cts.; fillers 7 cts.

DIFFERENT PARTS OF THE UNITED STATES.

Average yield per acre.	Character of soil.	Kind and amount of fertilizers applied per acre.	Does land depreciate with continued cropping?	Average value of tobacco lands per acre.
1000 pounds whole crop.	Red or gray with clay subsoil.	Stable manure with some commercial fertilizer.	Not with intelligent farming.	$8 to $10.
500 pounds	Light gray	200 lbs ammoniated fertilizer	Yes	$8 to $10.
600 to 700 lbs	Gray	200 to 400 pounds	Yes, but may be reclaimed by sowing in grass.	$12.
700 pounds	Light gray or sandy.	200 to 400 pounds	Not when properly cared for.	$12.
400 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
400 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
400 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
400 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
500 poynds	Light gray	Ammoniated fertilizer	Yes	$10.
500 pounds	Light gray	Ammoniated fertilizer	Yes	$10.
About 1300 lbs	Generally limestone; also some red sandstone and gravel.	Principally barnyard manure and sometimes commercial fertilizers.	No depreciation known.	$175 to $250.

The soils upon which were grown the different types of tobacco, the analyses of which are published in this bulletin, present a variety in character, treatment and value. We find here (No. 2) the soil which produced the highest priced wrapper, is a light sandy loam without any fertilizer. The yield in this case was small (500 to 600 pounds per acre), but the quality more nearly approaches that of Cuba than of any grown in this country. This is undoubtedly due partly to climate, as it was grown in Florida, where the climate closely approaches that of the West Indies. Of the seed-leaf varieties the next highest price shown was that grown in Connecticut This was upon a light sandy loam heavily manured with commercial fertilizing materials. The amount produced in this case was 1,800 pounds. Very similar to this was that grown in Massachusetts, which was also very heavily manured. It is believed from the analysis that the sample from New York is of better quality than either that grown in Massachusetts or Connecticut, but the price does not indicate it. This was grown upon a light sandy and gravelly loam with a comparatively small quantity of commercial fertilizer. Other varieties which were of exceptionally good value were the bright tobaccos (Nos. 9, 10, 14, and 27) from North Carolina and Virginia; these were grown upon light-gray sandy soils with small amount of fertilizers. The tobacco that had the lowest value quoted was No. 13, grown on a clay soil with 600 lbs. fertilizer and having a yield of about 550 pounds per acre. Next to this is No. 6, which was also grown on a clay soil with limestone foundation and a small coating of stable manure. Here also is found a sandy loam or a soil composed almost wholly of sand, producing the best quality, as indicated by the price.

A remarkable contrast in the use of fertilizers is illustrated between the New England growers and those of other sections. The growers of the seed-leaf varieties in Connecticut and Massachusetts make very heavy applications both of stable manure and commercial fertilizers, and from their statements the land is constantly growing better. This is probably true to the extent that it will produce heavier crops, but it is believed that there is some deterioration in quality, but not sufficient to compensate for the gain in quantity. This heavy manuring has brought up the yield per acre larger than that of any of the other sections reported. A deterioration of the soil is almost always reported where constant cropping is practiced, except where large amounts of manure are applied. A remarkable variation in values of tobacco lands may also be noticed. This valuation, however, is due mostly to local influences, rather to any special merits these soils may possess for the production of a fine quality of tobacco. Tobacco lands in Florida upon which are produced the best qualities of the seed-leaf type, are quoted at from \$3 to \$30 per acre, while those of Pennsylvania, New York, Connecticut and Massachusetts range from \$50 to \$250 per acre. Good "bright" tobacco lands in Virginia and North Carolina are quoted at from \$10 to \$30

per acre, while poorer lands are to be bought for $5 per acre. The prices in other sections have a range rather below the average of these extremes, but, as has been stated, these values hardly represent the merits of the respective soils for the production of the different grades of tobacco.

5. FERTILIZERS.

A survey of the facts obtained from different sections shows some remarkable variations in the kind and amounts of the various fertilizers used. In some sections little or none is employed, while in other localities it is not considered possible to grow a profitable crop of tobacco without applying large quantities of manure or commercial fertilizers. The best types produced in New England are grown upon lands very heavily manured with nitrogenous fertilizers, while those of North Carolina and Virginia are produced upon soils very poor in organic matter, and usually with the aid of comparatively small amounts of fertilizers. The result is that the yield on the highly fertilized lands of Connecticut, Massachusetts, etc., is from two to three times as large as is found in the localities mentioned. It is difficult to compare the respective qualities except by the commercial value, on account of the different types grown in these sections. The tobaccos raised in New England represent the best types of the seed leaf varieties, with the possible exception of Florida, while we find in North Carolina and Virginia the best varieties of yellow tobacco, both of which possess the qualities of fine smoking tobaccos, but the former is used for cigars and the latter for pipes, cigarettes, and wrappers for chewing tobacco.

The successful growth of different varieties must be chiefly attributed to the influences of soil and climate, but it may be said that few soils possess a large supply of the elements of available plant foods in suitable amounts to be most conducive to the production of a fine leaf, and any deficiency of this kind must be supplied in the shape of suitable fertilizers. For several reasons the tobacco crop requires a larger amount of fertilizers than most other crops. As its principal growth is accomplished in the hottest summer weather, and in a period from two to three months, it is essential that a larger amount of available plant food be present in the soil than would be necessary for crops of longer growth. This may partly account for the heavier manuring necessary in the northern latitudes, as the season is short, and the crop must be stimulated to quick maturity by the use of large amounts of fertilizing materials. It has been observed, also, that the best tobacco lands are light in texture, and thus suffer larger losses from drainage, decomposition, &c., than soils of a more compact nature.

In some respects the tobacco plant exhibits remarkable facilities for taking up and assimilating the various elements of plant food. There is hardly another agricultural plant capable of extracting so

large an amount of the different fertilizing materials and transforming them into such a variety of compounds as this one. It not only takes such elements in sufficient amounts to sustain and develop the various organs of the plant, but under certain circumstances it seems to incorporate such excessive proportions of food materials as to materially alter the character of the plant. An examination of the analyses of tobaccos grown in different sections under the influence of different soils and with various amounts and kinds of fertilizing materials, shows that the percentage of ash constituents of tobacco grown on lands poorly supplied with available mineral compounds, is very much lower than those grown on soils of the opposite character. The development of nicotine is also usually lower in proportion.

While it may be said that some of the finest qualities are produced on lands poorly supplied with organic matter and other fertilizing materials, it is generally considered that it pays well to fertilize heavily. In some instances, heavy manuring may produce a somewhat inferior quality, but if care is exercised in the kind and amount of fertilizers, the gain in quantity will more than compensate for the loss in quality. Different soils necessarily require different treatment, but generally speaking, good well-rotted stable manure gives probably the most satisfactory results of any fertilizer that can be applied. In addition to the plant food it contains, it has the advantage of supplying a large amount of humus, thus rendering the soil in a good physical condition, which requirement is so essential for the best development of the tobacco plant. This may be supplemented by such commercial fertilizers as may be required under different conditions.

It is generally agreed that the presence of large proportions of chlorine, has a deleterious effect on the burning qualities; for this reason fertilizers containing combinations of this element should be avoided when the product is to be a high grade for smoking purposes. By referring to the analyses of various types of tobacco, we find that the fertilizing ingredients taken up by the plant in largest quantities are lime, potash and nitrogen. Lime is usually present in the soil in sufficient quantities, but this is not often the case with potash, and nitrogen. Nessler found that tobacco which was manured with gypsum, contained a large amount of potassium carbonate in the ash, probably due to the fact that this compound is a partial solvent for the inert potash salts. Gypsum has been reported by different growers to have given good results. It not only supplies any deficiency of lime and sulphuric acid, but also aids in liberating other inert food compounds in the soil. Lime and marl may be employed in a similar manner. Potash seems to be the element most needed, but in order that its application may be accompanied with best results it must be applied in particular combinations,—either as sulphate or carbonate. Muriate of potash and kainit are to a great extent injurious on account of the chlorine contained. It has been

quite generally observed by investigators that large amounts of potassium carbonate, or potassium in some other combinations are conducive to the most perfect combustibility. Considering also, the large percentages of potash always present in the plant, and the probable beneficial effect of large amounts on the burning qualities of the leaf, it is believed that its application in proper form is required in larger proportions than is generally applied in commercial fertilizers.

The quality of smoking tobacco is judged to a great extent by its burning qualities; if it burns well, a greater amount of the nicotine is consumed and decomposed, and less of the narcotic products of combustion are created than when it burns badly. It is, therefore, important that such fertilizers be used as will best promote the process of combustion.

Excessive amounts of nitrogenous manures applied to the soil tend to produce a somewhat coarse and heavy growth, accompanied by the formation of a large percentage of nicotine and albuminoids in the leaf. The best smoking tobaccos contain a comparatively small percentage of these compounds, while the presence of a large percentage of albuminoids in the leaf is considered especially objectionable, causing it to burn badly and make it strong and disagreeable to the smoker. A great deal depends, however, on the conditions of soil and climate as to the development of these objectionable qualities in the plant. As was stated, some of the finest qualities of seed leaf tobacco are grown in Connecticut and Massachusetts, on lands where, by the use of highly nitrogenous manures, the average yields have been brought up to 1,800 pounds per acre, much larger than in other localities. It may be true that the quality has suffered somewhat in these instances but not sufficient to compensate for the gain in quantity. By referring to the analyses of these tobaccos, it will be seen that a very much larger percentage of the nitrogen exists as nitrate than is found in other cases, showing that a large portion of the nitrogenous food which has been taken into the plant in the process of nutrition, has not been changed into nicotine, albuminoids and other nitrogenous substances, but has accumulated and remains in the plant. Some tobaccos contain no nitrates. Their presence, in a measure, indicates the amount of nitrogen in the soil, but their formation as such seems to be of no especial importance, aside from the fact that they are generally favorable to combustion.

In addition to the use of stable manure, the deficiencies in nitrogen may be supplied by nitrate of soda, nitrate of potash, sulphate of ammonia, cotton seed meal, castor pomace, &c. Phosphoric acid is more generally deficient in the soil than the other mineral constituents required by plants, and needs to be supplied in suitable amounts. The percentage present in different tobaccos is quite uniform, and its presence in the soil in large or small quantities seems to have no especial effect on the amount present in the plant. Certain amounts are, however, required in connection with other elements to produce the best growth.

The following mixtures for tobacco, embodied from those published in Bulletin No. 61 of the N. C. Experiment Station make good formulas for home-mixing:

1. A strong mixture using cotton seed meal:

Acid phosphate	1,100 lbs.
Sulphate of potash	200 "
Cotton seed meal	600 "
Nitrate of soda	100 "
	2,000 lbs.

2. A cheap but good compost:

Acid phosphate	750 lbs.
Sulphate of potash	150 "
Nitrate of soda	100 "
Stable manure	1,000 "
	2,000 lbs.

3. Fine horse or cow manure, rich mould or similar

material	900 lbs.
Acid phosphate or dissolved bone	600 "
High grade sulphate potash	150 "
Fish scrap, cotton seed meal, or tankage	350 "
	2,000 lbs.

4. In New England, mixtures composed chiefly of cotton seed meal or castor pomace, and cotton seed hull ashes are being used with exceedingly good results.

6. THE DEVELOPMENT OF NICOTINE IN THE TOBACCO PLANT.

Nicotine, the active principle of tobacco, is present in the plant from the time it commences to grow in the seed bed until it has reached maturity and has gone through all the fermentative changes incident to curing, sweating, and manufacture. Every organ, from the minute rootlets which serve to gather food for the rapidly growing plant, to the mature seed, in which is stored the proper constituents to serve as food for the young plantlet, contain some trace of this alkaloid. From the analyses of different portions of the plant taken at different stages of growth, the results of which are shown in table III, it was found that the percentage of nicotine varied very much in the different parts, and this variation increases as the plant reaches maturity.

In the young plant taken from the seed bed, the roots contained a slightly larger percentage than the leaves, but in the process of growth the percentage in the leaf very soon exceeded that of any other portion of the plant, and continued to increase, until, at maturity, the nicotine present there was about three and one-half times greater than that in the roots. While there was some variation

noted in the roots, stalks, and stems during their various stages of growth, they were by no means so marked as in the leaves. It was also noticed in this and other experiments that the per cent. of nicotine was greater just as the leaf reached maturity than it was either in the green or over-ripe leaves. It would seem, therefore, that the formation and accumulation of nicotine in the leaf continues just as long as there is a manifestation of growth. After growth ceases, whether the leaf remains in its original position on the stalk, or whether it is subjected to the process of curing, it undergoes certain fermentative changes which alter its character to a certain degree, and in all probability decompose a small portion of the nicotine.

Just what office this poisonous principle has in the economy of the plant cannot definitely be stated; neither can it be said just what transformations take place in its production. Unlike the principle constructive substances of the cells and organs of plants in general, this compound, after it is once formed, in all probability is of no further use in the nutrition of the plant. It apparently remains useless in the economy of nature, only to satisfy a cultivated desire in the appetites of man.

Table III gives the percentage of nicotine, together with the total and nitric nitrogen existing in the different parts of the tobacco plant, sampled at different stages of growth. The table includes the analyses of roots, stems, stalks, and leaves of the plant sampled at several periods, beginning with the plant in the seed bed and ending with the cured leaf. The tobacco used in the experiment was what is known as yellow tobacco or "brights," common to certain sections of North Carolina, and was grown on a light sandy soil near Raleigh. From these results we can observe the ratio existing between the nicotine and nitrogen in other compounds, at intervals during the whole period of growth. It will be seen that a large percentage of nitrogen in the leaf is accompanied by a relatively large percentage of nicotine, in proportion to the length of time the plant has been growing.

The amount of nitrogen is largest in the early stages, while that of nicotine reaches its maximum at maturity. The other organs of the plant are accompanied by a much smaller percentage of these ingredients and the variations are not as marked.

It is now generally understood that the nitrogen of albuminoid substances is entirely derived from the salts of nitric acid, and is taken up through the roots in the process of nutrition. This is indicated in this experiment by the fact that in the early growth of the plant there is quite an amount of nitrogen present as nitrate, while later this has all been transformed into other combinations. In order to undergo this transformation, it must in some manner come in contact with the other constituents, which, in case of the albuminoids are carbon, hydrogen, and sulphur, which are in all probability derived from the carbohydrates assimilated by the chlorophyl, and sulphur from the sulphates taken up in the process of nutrition.

TABLE III. SHOWING THE EXISTENCE OF NICOTINE IN YELLOW TOBACCO AT DIFFERENT STAGES OF GROWTH, TOGETHER WITH TOTAL AND NITRIC NITROGEN.

Station No.	Part of Plant.	Where Sampled.	When Sampled.	Nicotine.	Per Cent. Nitrogen existing as Nitrate.	Total Nitrogen.
6007	Roots	From plant-bed	May 29	0.81	None.	2.32
6008	Stalks	" "	"	----	0.15	1.98
6009	Leaves	" "	"	0.76	None.	4.22
6010	Stems	" "	"	0.32	0.22	2.33
6011	Roots	From field	June 27	0.62	0.07	2.11
6012	Stalks	" "	"	0.74	0.51	2.52
6013	Leaves	" "	"	1.22	0.09	5.65
6014	Stems	" "	"	0.39	0.77	1.64
6015	Leaves (primed)	" "	"	1.39	None.	3.82
6016	Stems (primed)	" "	"	----	0.51	1.94
6017	Roots	" "	July 11	0.52	None.	1.38
6018	Stalks	" "	"	0.19	None.	1.01
6019	Leaves	" "	"	0.68	None.	2.71
6020	Stems	" "	"	0.28	None.	0.99
6021	Leaves (primed)	" "	"	1.07	None.	1.95
6022	Stems (primed)	" "	"	0.23	None.	1.04
6023	Tops	" "	"	----	-----	4.50
6024	Suckers	" "	July 27	0.42	None.	3.95
6025	"	" "	Aug. 12	0.41	None.	3.57
6026	"	" "	Aug. 31	0.45	None.	3.04
6027	Roots	" "	Sept. 2	0.45	None.	0.99
6028	Stalks	" "	"	0.42	0.03	0.91
6029	Leaves	" "	"	2.48	None.	1.94
6030	Stems	" "	"	0.36	None.	0.69
6031	Roots	From barn	Sept. 9	0.91	None.	1.17
6032	Stalks	" "	"	0.87	Trace.	1.41
6033	Leaves (smokers)	" "	"	2.92	None.	1.98
6034	Stems (")	" "	"	0.55	None.	0.69
6035	Leaves (tips)	" "	"	3.01	None.	1.93
6036	Stems (")	" "	"	0.84	None.	0.93
6037	Leaves (fillers)	" "	"	3.09	None.	2.17
6038	Stems (")	" "	"	0.55	None.	0.80
6039	Leaves (cutters)	" "	"	3.21	None.	2.01
6040	Stems (")	" "	"	0.55	None.	0.80
6550	Seed	----	----	0.26	None.	3.36
6553	Second growth	----	----	----	None.	1.55

All these substances come together in the plant, and chemical decomposition takes place, in which these salts yield their base, so that the nitrogen and sulphur may, after certain processes, come in combination with the carbohydrates to form albuminoids. If the same conditions are favorable to the development of both albuminoids and nicotine, it would naturally seem that they might be formed from the same substances in a similar manner—of course leaving out sulphur in the case of nicotine.

By referring to the table, it is noticed that in the early growth, the percentage of albuminoid nitrogen in the leaf is very large, while

that of nicotine is comparatively low. As the plant continues to grow, the albuminoid nitrogen decreases, while the nicotine increases, until at maturity the two substances reach their two extremes. This, with the fact that the nitric nitrogen is all present in the young growth, would indicate that the nicotine, instead of deriving its nitrogen directly from the nitric acid, withdraws some or all of it from the albuminoids. If this be true, it is still difficult to tell what tranformations take place in the development of this alkaloid, and also what conditions are favorable to its production.

It has been found in other analyses that the percentage varies very much in different samples. The percentage found in the whole leaf of tobacco grown in different portions of the United States, as given in table VI, ranges from 1.96 to 5.53. This variation is due in some measure to different varieties, but whatever variety is grown or what other conditions prevail, it is almost always noticed that those influences which tend to produce a coarse, rank growth, containing a large percentage of albuminoids, also produces a comparatively large amount of nicotine. The climate, nature of soil and fertilizers, treatment of crop, etc., all have their influence. Of all these conditions, that of soil and fertiliz-rs seems to be the most important. A rich heavy soil fertilized with a strong nitrogenous manure is very favorable to the production of a high percentage of nicotine, while the reverse is true of a light sandy soil containing little organic matter.

Havana grown tobacco, which contains a low percentage, has in addition to soil, the benefit of a very warm moist atmosphere. For this reason, some have attributed the reverse conditions as favorable to the production of nicotine. From the results of the investigation of tobaccos grown in the United States, we can find no ground for this assertion. Tobacco of the seed leaf variety grown in Connecticut on a rich loam gave over four per cent. of nicotine, while that grown on a sandy soil contained only about one per cent. There we have different conditions of soil in the same climate; and other instances of a similar character might be cited. As nicotine is the active principle of tobacco upon which the stimulating effect largely depends, it would naturally appear that its development to a high degree would be desirable, but such is not the case. What are considered the best qualities, almost always contain a small percentage, while a large percentage usually indicates coarseness. While, as stated, certain conditions are conducive to the development of nicotine, it is undoubtedly true that the subsequent treatment has some influence on the amount present in the finished product. The different fermentative processes required to develop proper flavor and color, necessarily decompose to a greater or less extent the different compounds present in the leaf.

It may be true, therefore, that in some cases the nicotine content may be appreciably less in the fermented product than was present in the green plant. For this reason the analyses of the different

varieties (given in tables IV, V, VI), which have been subjected to different processes of curing and fermenting, cannot safely be relied upon as giving the exact amount developed by certain conditions in the field, but the results in a general way confirm what has been previously noted.

7. ON SEPARATING THE STEM FROM THE LEAF IN TOBACCO ANALYSIS.

In speaking of tobacco as an agricultural product it is generally understood that we refer to that part of the plant which enters the market as an article of commerce: in other words it consists of the cured leaves, stripped from the stalks and tied in convenient bunches or "hands."

When this is received by the manufacturer, whatever is to be the form of the finished product, whether for smoking or chewing purposes, it is first divested of the mid-rib or stem; the remaining or leafy portions are then prepared to suit those demands of the market for which they are best adapted. The stems are no longer considered in the commercial article, except in the manufacture of snuff. Nearly all of the analyses of tobacco, which have heretofore been published, have comprised the whole leaf, stem included. If the stem and leaf are used for entirely different purposes, why should not their analyses be made separately? Roughly speaking, about one-fourth the weight of the entire leaf is stem, which is of entirely different character from the leafy portion, containing a much larger percentage of the mineral constituents and less nicotine and other injurious materials. Now if, in tobacco analyses, the whole leaf is used for the determination, the results cannot possibly convey any correct idea of the character of the part of the leaf which is actually used in manufacture. Chemical analysis of tobacco, then, if it is ever to be of value in its manufacture, should certainly be made of that part of the plant which actually enters into the composition of the manufactured product.

It is true that heretofore chemical analysis has not been utilized in the manufacture, except possibly in the preparation of snuff; but it is very probable that before very long the tobacco industry, like most other manufacturing interests, will require some assistance from a thorough chemical examination. The analysis of tobacco either from a scientific or industrial standpoint has, as yet, received comparatively little attention, and the various relations between the different constituents and their influence on quality as best suited for different purposes, have been but partially developed. While the leaf is the principle and most valuable portion, the analysis of the stem is also useful; but serving an entirely different purpose, it should never enter into consideration of the general composition of the leaf for manufacturing purposes.

The stems are utilized to some extent in the manufacture of snuff,

and also in the manufacture of fertilizers, for which purposes their usefulness and value can only be determined by analysis, as there are marked variations in different varieties. Heretofore it has been the custom of chemists to draw conclusions concerning the different properties of the valuable portion of the leaf from an analysis of the whole leaf. While this may be a step in the right direction, it must necessarily be far from reliable. For example: it has been generally observed that the presence of chlorine has a deleterious effect on the burning qualities of tobacco. In table IV, it will be noticed that the percentage of chlorine in the leaf may be quite small, while that of stem (table V) invariably contains more, and in some cases five to six times the amount, in the leaf. If the analysis of the whole leaf had been considered, and the burning qualities judged by the percentage of chlorine an erroneous conclusion must necessarily have been reached.

In like manner the bearing of the other constituents on the various properties must vary as their percentages vary in the stem and leaf. The practice of separating the leaf from the stem in the preparation of the sample for analysis, was first adopted at this Station, and the result published in technical bulletin No. 5. The same plan has been followed in the analysis published in this bulletin, comprising a partial analysis of tobaccos grown in the principal tobacco sections of the United States, and giving the percentages of those ingredients which are supposed to have the most effect on quality. It is believed that an examination of the analyses shows conclusively that the manner of preparation of the sample is essential in obtaining a fair comparison and in representing facts which will prove of much practical value either from an economic or scientific standpoint.

8. THE COMPOSITION OF VARIOUS TOBACCOS.

The following description of typical tobaccos, the composition of which are presented in tables IV, V, and VI, while not as complete in all cases as would be desired, presents such facts in connection with some of the typical samples already partially described in table II, as could be obtained from that source. Some other samples are inserted which were collected from other states by the Museum Division of the U. S. Department of Agriculture, to the officials of which we are indebted for much kind assistance.

1. Domestic Havana Eureka. Grown by Henry Lewis, Baldwinsville, Onondaga Co., New York. This leaf is about 24 in. long, 9 in. wide, thin, fine, and silky, and has a dark, greenish-brown color. It is used in the manufacture of cigars, chiefly as wrappers and binders. The average yield per acre was given as 1,300 lbs., and the average price per pound was 30 cents for wrappers, 12 cents for binders, and 7 cents for fillers. The soil was a sandy and gravelly loam, upon which 500 lbs. of commercial fertilizer was used. The

value of tobacco lands in this section ranges from $50 to $250 per acre. The land does not depreciate in value with proper care.

2. Cigar Leaf Wrapper. Grown by F. B. Moodie, Lake City, Columbia Co., Fla. The leaf is rather below the medium size, measuring about 19 in. in length and 6 to 7 in. wide. It is thin, having a very fine texture, and is very glossy and silky. The color is light brown. It is used for fine cigar wrappers. The average yield is from 500 to 1,000 lbs. per acre, and the value of the wrappers ranges from $2 to $4 per pound, while for fillers it is less. The soil upon which this tobacco was grown is a light sandy loam, free from lime or clay, upon which no fertilizer was ever applied, and this was the sixth consecutive crop on this piece of land. The value of tobacco lands in this section varies from $3 to $30 per acre.

3. London Strips. Grown by B. F. Mayfield, Owensboro, Ky. This tobacco has a leaf about 24 to 25 in. long, and 10 to 11 in. wide. The leaf is of medium thickness, rather coarse, and has a color ranging from medium brown to mahogany. It is grown for the English trade, and is manufactured into a coarse product known as shag. The average yield per acre is 1,000 lbs., and the value per pound is 9 pence in London. The soil was a clay sandy loam with no fertilizer. Land depreciates after three years from time of clearing. The value of tobacco lands in this section ranges from $25 to $100 per acre.

4. Kentucky White Burley. Grown in Bracken Co., Ky. This is a large leaf, measuring about 30 in. in length, and 11 in. in width, of thin tissue, and owing to the small percentage of gums and oils, is rather dry and harsh. The color is a bright brown or golden, and evenly colored. It is grown for both domestic and foreign trade, and is used in the manufacture of plug, fine cut, and smoking tobacco. The average yield per acre is 1,000 pounds, and the average price per pound 10 cents. The tobacco was grown on a limestone soil with no fertilizer. Land depreciates with continual cropping. The average value of tobacco lands in this section is $50 per acre.

5. Wilson's Hybrid Havana. Grown by Frank Scott, North Hadley, Hampshire Co., Mass. This leaf measures about 24 in. in length, and 12 in. in width. It is of medium brown color, very thin, fine in texture and somewhat silky, but hardly as much so as some of the Havana seed specimens. It is used for cigar wrappers. The yield per acre is from 1,400 to 1,800 lbs., and the value per pound ranges from fifteen to twenty-five cents. The crop was grown on a light sandy soil upon which fertilizer was applied as follows: 600 lbs. sulphate potash, 1,000 lbs. dried fish, 1,000 lbs. cotton seed meal, and 6 cords barnyard manure. The land grows better by continual cultivation. The average value of tobacco lands in this section is $200 per acre.

6. German Spinning Leaf. Grown in Montgomery Co., Tenn. The leaf is from 20 to 24 in. long, and 10 to 11 in. wide. It has a

heavy body, fine fiber and stem, tough and elastic in texture, and has a deep or dark brown color. This tobacco is grown for the trade of Germany, Norway, and Sweden, and is manufactured mostly into twist for chewing. The yield per acre is from 1,000 to 1,200 lbs., and the price ranges from 7½ to 11 cents, according to quality. The tobacco was grown on a red clay soil, with limestone foundation, upon which a coating of stable manure was applied. Land depreciates with continual cropping, but not with rotation of crops. The value of tobacco lands in this section varies from $25 to $40 per acre.

7. Pennsylvania Seed Leaf. Grown in Pennsylvania. This specimen has dark brown color, thin leaf, but somewhat thicker and coarser than the ordinary seed leaf specimens. The leaves are about 26 in. long and 9 in. wide. This tobacco is used for cigar wrappers and fillers. The yield per acre ranges from 1,300 to 1,800 lbs.; the value for wrappers is 20 cents, and fillers 7 cents per pound. This tobacco was grown on a limestone soil with stable manure as fertilizer. The value of tobacco lands ranges from $175 to $250 per acre.

8. Havana Seed Leaf. Grown by Harrison H. Austin, Suffield, Hartford Co., Conn. This is a good sized leaf, fine-fibered, thin, soft, silky, and light brown in color. The average length of the leaves is about 24 in., and the width 9 in. This tobacco is used for cigar wrappers. The average yield per acre is about 1800 lbs., and the average value per pound 50 cents. The soil was a light loam upon which fertilizers were applied as follows: 600 lbs., sulphate potash, 1 ton cotton seed meal, 400 lbs., ground bone, and 300 lbs., oyster shell lime, all mixed together and sowed broad-cast. Land improves by cropping. Average value of tobacco lands, $200 per acre.

9. Bright yellow Tobacco (Fancy English Strip). Grown by W. T. Johnston, Cedar Cliff, Alamance Co., N. C. This is a very bright, smooth, thin and clean leaf. It is very soft and pliable and is a good representative of the bright yellow tobacco peculiar to certain parts of North Carolina. The leaf is about 20 in. long, and 11 in. wide. It is grown for English manufacture, and is largely used for plug. 100 lbs., of this grade, valued at 45 cents per pound, is grown on an acre, together with 400 lbs of commoner grades. The soil is light sandy, with sandy subsoil, upon which 400 lbs., of commercial fertilizer was applied. The land depreciates with cropping. Average value of tobacco lands is $10 per acre.

10. Bright Wrapping Leaf. Grown by W. L. Wilson, Ringgold, Pittsylvania Co., Va. A broad, short, thin, and fine leaf, of silky texture and light yellow color. This is another specimen of the "bright" tobacco. The leaf is about 18 in., long and 10 in. wide. It is used in the manufacture of smoking tobacco for the English trade. The average yield per acre is about 500 lbs., and the price per pound 25 cents. The land upon which this tobacco was grown was a light-gray sandy soil, upon which some commercial fertilizer was applied. The land depreciates by continual cropping. The average value of tobacco lands is $10 per acre.

11. Austrian Wrapper. Grown in Virginia. A dark brown leaf, smooth and medium fine in fiber, firm and glossy texture, of good body, but not of the heaviest type. The leaf is about 24 in., long and 10 in., wide. This tobacco is grown for export trade and is manufactured into cigars and plug. The yield per acre is from 1,200 to 1,500 lbs., of which this grade of wrappers constitutes a part. The value of this grade is from 15 to 18 cents per pound.

The soil is red or gray, with a clay subsoil, fertilized with stable manure and commercial fertilizer. Land does not depreciate in value with intelligent farming. Tobacco lands are valued at from $8 to $10 per acre.

12. Italian Regie Cigar Wrapper. Grown in Virginia. A dark brown leaf of moderate weight, having a medium fine fiber and texture. The leaf is 23 to 24 in. long, and 8 to 9 in. wide. It is used for the Italian Regie trade and is manufactured into cigars. The yield is from 800 to 1,000 lbs., per acre, bringing an average price of 14 cents per pound. This tobacco was grown on a clay soil upon which which was used 600 lbs. of fertilizer. The land depreciates by constant cropping. The average value of tobacco lands is $5 per acre.

13. French Regie Snuff Leaf. Grown in Virginia. A coarse, thick leaf about 20 in. long and 8 in. wide. This tobacco has a very dark brown color, an unusually heavy body, and presents a rough unattractive appearance, being for the most part roughly crumpled about the stem. It is used for the French Regie trade and is manufactured into snuff. The average yield per acre is about 550 pounds, which has an average value of 7 cents per pound. The tobacco was grown on a clay soil, upon which about 600 lbs. of fertilizer was applied. The land depreciates with continual cropping. Tobacco lands in this section are worth $5 per acre.

14. Fine Bright Mahogany Wrapper. Grown in Virginia. A rather small leaf of medium thickness, medium fine, silky, elastic, and of a light-golden brown color. The leaf is about 18 in. long, and 6 to 7 in. wide. It is used for wrapping fine plug and twist, and ranges in value from 25 to 40 cents per pound.

15. Ohio Spanish. Grown in Ohio. A medium size thin leaf of the seed-leaf type. The color is light to medium brown, texture fine and silky, and altogether presents a smooth and handsome appearance. This leaf is about 19 to 20 in. long and 9 in. wide, and is used in the manufacture of cigars.

16. Small Dark Wrapper. Grown in Virginia. A rather coarse leaf, with good body, thick, tough and elastic. The color is very dark brown. The leaf measures 21 in. in length, and 8 to 9 in. in width. It is used principally for export trade and is manufactured into plug and twist. Its value ranges from 11 to 12½ cents per pound.

17. Maryland Leaf Tobacco. Colory Seconds. Grown in Maryland. A light reddish brown leaf, measuring about 20 in. in length and 10 in. in width. This is a leafy tobacco without much body, thin,

coarse and inclined to be trashy. It is used in the manufacture of smoking tobacco.

18. White Burley. Grown in Ohio. A large handsome leaf, of a bright brown or golden color. It has a thin leaf, rather dry, but possesses enough toughness and elasticity to handle fairly well. The leaf is 30 in. long, and 11 in. wide. It is used in the manufacture of plug, fine cut and smoking tobaccos, mostly for home trade. This variety is more extensively grown in Ohio than any other.

19. Yellow Tobacco. Grown in Georgia. A broad medium-sized leaf, measuring about 21 in. in length, and 10 in. in width. Its color is light-golden yellow, and is about the same type as the yellow tobacco of North Carolina. The leaf has a medium thickness and is soft, tough and elastic, but slightly coarse for this variety.

20. Yellow Tobacco. Grown in Alabama. A short broad leaf of medium thickness belonging to the type known as "bright" tobacco. The color is a mottled light brown with yellow; it is quite tough and silky but somewhat coarse. The leaf is about 20 in. long and 11 in. wide.

21. Kansas Tobacco. This sample is a very uniformly colored reddish brown or cinnamon tobacco. The leaf is about 21 in. long and 10 in. wide, medium thickness and light body. It is rather dry, not having oily material sufficient to make it soft and pliable.

22. Mississippi Tobacco. A rather small leaf of dark reddish brown color, having a length of about 19 in. and a width of 9 in. It is of medium thickness and rather coarse.

23. White Burley. Grown in West Virginia. A large smooth tobacco of bright brown color. The leaf is about 28 in. long and 11 to 12 in. wide, thin, light body, fine fibre but not very tough. Used largely for the manufacture of plug and smoking tobacco.

24. Illinois Seed Leaf. Grown in Illinois. A very thin, tender leaf of medium size, having a uniform medium to dark brown color. It resembles the Connecticut seed leaf, except that it has a little better color and is more tender, requiring very careful handling. The leaf is about 22 in. long and 10 in. wide. It is used in the manufacture of cigars.

25. Indiana Tobacco. Grown in Indiana. This sample has a leaf about 25 in. long, 11 in. wide, rather thin, light body and of light brown color. It is of about the same type as the Kentucky White Burley, but the leaf is somewhat thicker and darker in color.

26. Spanish Type of Tobacco. Grown in Tennessee. This tobacco has dark brown, thick and gummy leaf of medium size, but rather coarse. It measures about 21 in. in length and 9 in. in width. The leaf is not uniformly colored, presenting a mottled appearance.

27. Bright Wrapping Leaf. Grown in Granville county, N. C. A medium sized broad leaf, which was flue-cured on the stalk and is of a light yellow color, or what is usually termed "bright" tobacco. The leaf is thin, soft, fine fibered, and tough. The best grades are used for plug wrappers and the poorer qualities largely for the man-

ufacture of smoking tobacco. It was grown on a light sandy soil upon which some commercial fertilizer was used. The usual crop is from 600 to 1,000 pounds per acre. Tobacco lands are worth from $10 to $25 per acre.

28. Bright Wrapping Leaf. Grown in Granville county, N. C. A medium sized broad leaf similar to No. 27, but was "flue cured" by the "leaf process" on wire.

29. Mahogany Wrapper. Grown in Granville county, N. C. The leaf is medium-to-large in size, and of a light mottled mahogany color. It is of medium thickness, soft, fine fibered, and tough. The best grades are used for plug wrappers and the poorer qualities of this type go into cutters and smokers. This sample was grown on a sandy loam, somewhat heavier than that which grows the brighter varieties. The usual crop is from 700 to 1,200 pounds per acre. Tobacco lands are worth from $10 to $25 per acre.

The Analyses of the Tobacco.

The samples just described, when received at the Station, were carefully unpacked, and allowed to "come in order" in suitable moist weather; the leafy part was then separated from the stem, and the two portions dried at the temperature of the grinding room. The samples after being weighed were ground so as to pass a 36-in. sieve and preserved in air-tight jars for analysis. The methods followed were those published in No. 90*a* of this Station.

Table IV. gives the results of the analyses of the leaves exclusive of mid-rib; table V., those of the midribs; and table VI., the results of the two combined in proper proportions to form the whole leaf. All results are calculated to a water-free basis.

9. BURNING QUALITIES.

In testing the combustibility of tobacco leaves, it is impracticable to supply all the conditions which accompany the burning of the commercial product in the hands of the smoker. We may however compare in a measure the capacity of different varieties for holding fire, which property constitutes an important factor in the make-up of a first-quality smoking tobacco. The following comparative tests (table VII) were made from strips cut from different parts of the leaf, running from the edge to the midrib and avoiding the lateral ribs. These were pressed out flat and dried; the strips were then ignited on one end, and the time noted during which the leaf continued to glow. This was repeated on the other end and the middle of the strips. Several parts from the same, and different leaves of the same lot, were tested in like manner and the results averaged. While the results show a considerable range, even in different leaves of the same sample, they furnish a basis of comparison which represents fairly well the relative burning qualities of the different varieties.

TABLE IV.—COMPOSITION OF TYPICAL TOBACCOS. ANALYSES OF TOBACCO LEAVES (EXCLUSIVE OF MID-RIB) REDUCED TO A WATER FREE BASIS.

Station number.	Where grown and Variety or Type.	Nicotine.	Ether extract.	Albuminoids.	Nitrogen in nitrates.	Ammonia.	Cellulose.	Sand.	Ash exclusive of sand.	Potash.	Lime.	Chlorine.
468	New York: Domestic Havana Eureka	2.96	4.80	11.45	.00	0.60	9.68	1.07	21.75	6.31	7.27	0.69
469	Florida: Cigar Leaf Wrapper	3.04	9.19	9.80	.00	0.34	9.15	5.78	20.58	5.61	7.64	0.38
470	Kentucky: London Strips	4.75	10.36	9.03	.00	0.41	8.82	0.88	13.96	3.42	4.93	0.17
471	Kentucky: White Burley	6.34	5.88	14.02	0.13	0.90	8.32	0.45	18.10	5.44	6.78	0.15
472	Massachusetts: Wilson's Hybrid	4.83	4.09	14.51	0.49	1.17	8.33	1.96	20.06	4.21	...	0.25
473	Tennessee: German Spinning Leaf	6.44	6.63	15.32	0.12	0.97	10.09	1.99	14.05	5.31	3.85	0.10
474	Pennsylvania: Pennsylvania Seed Leaf	1.70	3.70	9.56	0.07	0.46	8.47	0.69	26.82	5.98	8.49	0.88
475	Connecticut: Havana Seed Leaf	4.44	6.67	8.07	0.44	0.68	9.31	1.85	20.92	5.32	5.72	0.42
476	North Carolina: Fancy English Strip	3.30	8.96	6.30	.00	0.11	7.84	0.26	12.60	2.14	6.80	0.36
477	Virginia: Bright Wrapping Leaf	2.67	6.65	7.22	.00	0.14	6.39	0.42	10.31	2.31	5.06	0.25
478	Virginia: Austrian Wrapper	2.80	9.02	16.50	.00	0.72	7.88	2.07	13.36	3.27	7.42	0.27
479	Virginia: Italian Regie	5.10	5.91	11.16	.00	0.65	9.47	1.07	16.03	3.52	7.32	0.22
480	Virginia: French Regie Snuff Le'f	4.76	2.00	15.19	0.15	1.18	8.82	2.81	18.95	3.42	5.22	1.66
481	Virginia: Fine Bright Mahogany Wrapper	4.76	7.37	8.42	.00	0.15	5.45	3.16	11.18	3.01	1.68	0.60
496	Ohio: Ohio Spanish	4.24	4.57	11.72	0.13	1.73	9.27	1.19	20.20	4.89	6.00	0.20
497	Virginia: Small Dark Wrapper	6.08	5.50	12.51	.00	0.42	7.33	2.25	14.71	3.02	5.30	0.15
582	Maryland: Colory Sec'nds	2.05	8.26	10.39	.00	0.14	13.25	7.22	14.97	4.52	3.57	0.62
583	Ohio: White Burley	3.45	5.62	20.25	0.59	1.29	9.81	0.54	21.73	6.23	5.82	0.40
584	Georgia: Yellow tobacco	2.45	6.65	8.71	.00	0.13	8.55	0.52	12.36	3.58	3.02	0.88
585	Alabama: Yellow tobacco	5.26	5.88	14.34	.00	0.25	8.98	1.40	14.87	2.53	4.23	0.73
586	Kansas: Reddish brown	5.32	4.72	18.89	0.38	1.16	8.65	2.48	16.36	2.37	5.95	0.43
587	Mississippi: Reddish brown	4.00	7.05	13.69	.00	0.49	11.23	1.72	14.76	4.51	3.89	0.58
588	West Virginia: White Burley	4.49	7.15	15.44	.00	0.87	10.84	1.81	17.50	5.38	5.23	0.60
589	Illinois: Seed Leaf	5.70	5.01	9.91	0.12	1.42	9.29	0.65	20.71	3.74	3.72	0.48
590	Indiana: Light brown	5.38	6.52	17.49	0.28	1.11	8.87	1.49	18.53	4.58	5.71	0.61
591	Tennessee: Spanish type	4.45	7.55	14.92	0.09	0.75	7.71	1.35	20.69	2.65	5.56	0.39
13	North Carolina, Granville County: Flue-cured on stalk	3.23	8.31	7.56	.00	1.31	7.05	0.56	10.54	2.24	3.32	0.50
12	North Carolina, Granville County: Flue-cured by leaf process	2.84	7.94	6.94	.00	1.61	7.03	3.62	10.66	1.93	3.68	0.65
20	North Carolina, Granville County: Mahogany Wrapper	3.02	8.18	8.15	.00	0.12	6.34	0.25	9.69	....	....	....

TABLE V.—COMPOSITION OF TYPICAL TOBACCOS. ANALYSES OF TOBACCO STEMS (OR MID-RIB) REDUCED TO A WATER FREE-BASIS.

Station Number.	Where grown and variety or type.	Nicotine.	Ether extract	Albuminoids.	Nitrogen in nitrates.	Ammonia.	Cellulose.	Sand.	Ash exclusive of sand.	Potash.	Lime.	Chlorine.
482	New York: Dom. Havana Eureka	0.61	1.25	9.10	0.23	0.38	20.81	0.73	27.43	12.10	0.63	0.44
483	Florida: Cigar Leaf Wrapper..	0.79	2.40	8.72	0.10	0.08	24.94	3.59	26.32	10.53	2.52	0.88
484	Kentucky: London St'ips	0.84	1.88	7.98	.00	0.12	18.36	0.30	24.01	10.35	12.49	0.39
485	Kentucky: White Burley	1.30	0.98	9.19	1.02	0.55	19.05	0.08	27.23	12.67	10.02	0.65
486	Massachusetts: Wilson's Hybrid......	0.95	0.77	8.96	2.22	1.13	19.71	0.38	23.81	9.75	2.85	1.04
487	Tennessee: German Spinning Leaf	2.10	2.72	10.07	0.65	1.18	15.94	1.09	19.85	7.66	1.98	0.45
488	Pennsylvania: Penn. Seed Leaf......	0.50	2.27	8.13	0.03	0.23	23.09	0.31	28.49	7.45	6.84	1.71
489	Connecticut: Havana Seed Leaf....	1.01	1.09	9.22	1.76	0.38	21.10	0.53	27.06	12.11	2.52	0.97
490	North Carolina: Fancy English Strips..	0.88	1.04	5.99	.00	0.06	17.79	0.07	19.81	6.79	4.71	1.85
491	Virginia: Bright Wrapping Leaf	0.60	1.50	6.83	.00	0.05	16.57	0.26	18.27	7.33	3.15	1.27
492	Virginia: Austrian Wrapper....	3.68	2.58	9.5.	0.18	0.40	16.72	0 82	20.43	7.00	5.07	1.74
493	Virginia: Italian Regie..	1.98	2.96	8.93	0.04	0.53	17.90	0.40	21.43	7.45	5.05	0.36
494	Virginia: French Regie Snuff L'f	1.90	0.45	11.16	0.41	1.41	17.84	1.89	18.61	4.85	4.66	2.32
495	Virginia: Fine Bright Mahogany Wrapper...... ..	0.99	1.92	6.96	0.03	0.20	17.88	0.20	19.79	8.03	3.26	0.20
498	Ohio: Ohio Spanish...	1.27	0.82	9.00	0.43	1.21	20.06	0.36	22.35	10.20	12.22	0.36
499	Virginia: Small Dark Wrapper.	1.62	1.28	7.54	0.07	0.36	15.86	0.74	23.17	6.02	13.84	0.56
592	Maryland Colory Seconds	0.51	1.76	4.28	0.22	0.09	24.19	1.39	22.48	10.72	2.48	0.99
593	Ohio: White Burley....	0.53	0.97	10.95	2.14	0.75	19.22	5.67	21.68	12.75	2.94	1.27
594	Georgia: Yellow tobacco	0.57	1.58	4.09	.00	0.07	18.47	0.25	19.78	7.39	3.76	2.57
595	Alabama: Yellow tobacco.......	1.23	1.84	5.90	0.14	0.36	15.97	1.09	20.38	6.78	4.80	2.18
596	Kansas: Reddish brown	1.17	0.93	8.73	1.07	0.99	19.06	1.55	19.94	5.40	5.23	0.57
597	Mississippi: Reddish brown.......	0.64	1.67	8.15	0.13	0.22	22.12	1.04	17.68	9.86	0.60	1.53
598	West Virginia: White Burley	0.81	1.17	7.15	0.46	0.66	21.49	0.21	26.29	11.47	3.57	0.63
599	Illinois: Seed Leaf.....	1.44	1.25	7.59	0.46	1.07	20.84	1.09	23.58	9.40	3.84	1.41
600	Indiana: Light brown..	1.29	0.87	7.00	1.32	0.88	19.64	0.42	24.99	10.86	3.19	0.53
601	Tennessee: Spanish type	1.50	2.08	6.14	0.53	0.53	17.21	2.17	23.06	7.19	5.79	0.75
34	North Carolina, Granville County: Flue-cured on stalk.	0.72	3.31	4.81	.00	1.13	18.49	0.21	17.37	4.81	4.16	1.06
33	North Carolina, Granville County: Flue-cured by leaf process.............	0.49	1.72	4.69	.00	1.19	19.43	0.75	18.27	5.11	4.45	2.98
41	North Carolina, Granville County: Mahogany Wrapper	0.53	1.41	4.45	.00	0.70	17.06	0.25	18.13	.....	.....	.....

TABLE VI.—COMPOSITION OF TYPICAL TOBACCOS. ANALYSES OF WHOLE TOBACCO LEAVES, CALCULATED FROM THE DIRECT ANALYSES OF STEMS AND LEAVES (EXCLUSIVE OF STEMS), AND REDUCED TO A WATER-FREE BASIS.

Descriptive Number.	Where grown and Variety or Type.	Leaf without stems.	Stems.	Whole leaf.	Nicotine.	Ether Extract.	Albuminoids.	Nitrogen in nitrates.	Ammonia.	Cellulose.	Sand.	Ash exclusive of sand.	Potash.	Lime.	Chlorine.
1	New York: Domestic Havana Eureka	66.0	34.0	100.	1.96	3.59	10.65	0.08	0.53	13.46	0.95	24.68	8.29	5.01	0.61
2	Florida: Cigar Leaf Wrapper	71.3	28.7	100.	2.40	7 24	9.50	0.03	0.27	13.61	5.15	22.23	7.02	6.17	0.52
3	Kentucky: London Strips	69.1	30.9	100.	3.54	7.74	8.70	.00	0.32	11.77	0.70	17.16	5.51	7.26	0.24
4	Kentucky: White Burley	66.4	33.6	100	4.65	4.03	12.40	0.43	0.78	11.92	0.33	21.17	7.87	7.87	0.32
5	Massachusetts: Wilson's Hybrid Havana	67.3	32.7	100.	3.56	3 00	12.70	1.05	1.16	12.05	1.44	21.28	6.02	----	0.45
6	Tennessee: German Spinning Leaf	79.2	20.8	100.	5.53	5.82	14.03	0.24	1.01	11.31	1.80	15.26	5.80	3.47	0.17
7	Pennsylvania: Pennsylvania Seed Leaf	70.6	29.4	100.	1.45	3.28	9.15	0.06	0.39	12.77	0.58	27.31	6.41	8.00	1.12
8	Connecticut: Havana Seed Leaf	68 5	31.5	100.	3.36	4.91	8.27	0.86	0.58	13.02	1.43	22.85	7.46	4.71	0.59
9	North Carolina: Fancy English Strips	77.5	22.5	100.	2.76	7.18	6.23	.00	0.10	9.97	0.22	14.22	3.19	6.33	0.70
10	Virginia: Bright Wrapping Leaf	77.2	22.8	100.	2.20	5.68	7.13	.00	0.12	8.71	0.38	12.12	3.45	4.62	0.48
11	Virginia: Austrian Wrapper	74.8	25.2	100.	3.02	7.40	14.73	0.05	0.64	10.11	1.75	15.14	4.21	6.73	0.64
12	Virginia: Italian Regie	76.2	23.8	100.	4.35	5.21	10.83	0.01	0.62	11.47	0.91	17.33	4.46	6.78	0.25
13	Virginia: French Regie Snuff Leaf	75.4	24.6	100.	4.05	1.62	14.20	0.21	1.24	11.04	2.58	18.87	3.77	5.08	1.82
14	Virginia: Fine Bright Mahogany Wrapper	75.1	24.9	100.	3.82	6.01	8.06	0.01	0.16	8.54	2.42	13.30	4.26	2.07	0.50
15	Ohio: Ohio Spanish	69.5	30.5	100.	3.33	3.43	10.89	0.22	1.59	12.56	0.94	20.85	6.51	7.90	0.25
16	Virginia: Small Dark Wrapper	83 3	16.7	100.	5.33	4.78	11.67	0.01	0.41	8.75	2.00	16.22	3.52	6.73	0.22
17	Maryland: Colory Seconds	72.4	27.6	100.	2.51	6.47	8.70	0.06	0.13	16.26	5.61	17.03	6.23	3.27	0.72
18	Ohio: White Burley	71.0	29.0	100.	2.60	4.27	17.55	1.04	1.13	12.73	2.03	21.72	8.12	4.98	0.65
19	Georgia: Yellow Tobacco	78.5	21.5	100.	2.04	5.56	7.72	.00	0.12	10.68	0 46	13.96	4.40	3.18	1.24
20	Alabama: Yellow Tobacco	78.9	21.1	100.	4.41	5.03	12.56	0.03	0.23	10.45	1.33	16.03	3.43	4.35	0.62
21	Kansas: Reddish brown	77.2	22.8	100.	4.37	3.86	16.57	0.54	1.12	11.01	2.27	17.18	3.06	5.78	0.46
22	Mississippi: Reddish brown	78.2	21.8	100.	3 27	5.88	12 56	0.03	0.43	13.60	1.57	15.40	5.68	3.16	0 79
23	West Virginia: White Burley	70.4	29.6	100.	3.40	5.38	12.99	0.14	0.81	13.99	1.34	20.10	7.18	4.74	0.61
24	Illinois: Seed Leaf	69.5	30.5	100.	4.38	3.86	9 20	0.22	1.31	12.81	0.78	21.59	5.47	4.76	0.77
25	Indiana: Light brown	73.8	26.2	100.	4.31	5.04	14.74	0.55	1.05	11.70	1.21	20.22	6.96	5.05	0.59
26	Tennessee: Spanish type	75.6	24.4	100.	3.73	6.11	12.78	0.27	0.71	10.03	1.53	21.27	3.86	5.62	0.48
27	North Carolina, Granville County: Flue cured on stalk	79.6	20.4	100.	2.72	7.29	7.00	.00	0.13	9.38	0.49	11.93	2.72	3.58	0.80
28	North Carolina, Granville County: Flue cured by leaf process	79.9	20.1	100.	2.37	6.69	6.49	.00	0.15	9.52	3.05	12.18	2.50	3.92	1.05
29	North Carolina, Granville County: Mahogany Wrapper	79.0	21.0	100.	2.50	6.76	7.38	.00	0.11	8.59	0.25	11.48	----	----	----

TABLE VII.—BURNING QUALITY OF TOBACCO, SHOWING GLOW IN SECONDS.

Station Numbers.	Where Grown and Variety or Type.	Glow in Seconds. Average.	Range.
468	New York: Domestic Havana Eureka	14	5—35
469	Florida; Cigar leaf wrapper	117	Burned to end of strip.
470	Kentucky; London strips	8	5—25
471	Kentucky; White Burley	7	4—18
472	Massachusetts; Wilson's Hybrid	13	5—28
473	Tennessee; German Spinning Leaf	11	7—15
474	Pennsylvania; Pennsylvania Seed Leaf	175	Burned 2½ ins. and put out.
475	Connecticut; Havana Seed Leaf	16	4—45
476	North Carolina; Fancy English Strips	5	4—6
477	Virginia; Bright Wrapping Leaf	4	2—8
478	Virginia; Austrian Wrapper	5	3—8
479	Virginia; Italian Regie	31	10—90
480	Virginia; French Regie Snuff Leaf	5	3—8
481	Virginia; Fine bright mahogany wrapper	6	4—8
496	Ohio; Ohio Spanish	24	8—50
497	Virginia; Small dark wrapper	24	14—50
582	Maryland; Colory Seconds	39	15—65
583	Ohio; White Burley	4	2—6
584	Georgia; Yellow tobacco	4	2—8
585	Alabama; Yellow tobacco	6	4—10
586	Kansas; Reddish brown	6	4—10
587	Mississippi; Reddish brown	6	5—7
588	West Virginia; White Burley	52	15—150
589	Illinois; Seed Leaf	12	4—30
590	Indiana; Light Brown	10	5—25
591	Tennessee; Spanish type	15	5—40
12	North Carolina; bright wrapper, leaf cure	5	3—7
13	North Carolina; bright wrapper, stalk "	5	4—7
10	North Carolina; yellow, smoker, leaf "	8	4—13
6	North Carolina; yellow, smoker stalk "	7	4—12
100	North Carolina; yellow, cutter, leaf "	8	4—15

10. RELATION EXISTING BETWEEN CHEMICAL COMPOSITION AND BURNING QUALITY.

The essential property of a good smoking tobacco is that it will hold fire after being ignited, and will burn to a light gray or white ash, and in the case of cigars, that the ash will hold together. Color, flavor, etc., are all important qualities in determining the value of the different varieties, but if the leaf does not possess good burning qualities, it is impossible to produce a product of first quality for smoking purposes. Why some tobaccos burn well and others badly may not fully be understood, but it has been determined that there are certain elements which enter into the structure and composition of the leaf, which may either promote or retard combustion. The curing and sweating processes result in essential modification of the organic portions of the plant, but the results of investigation have shown that the burning qualities, while more or less modified, are

more largely dependent upon the composition of the ash constituents than upon the extent of fermentation. By comparing the compositions of the different samples with the resulting combustibility, we are able to determine, to some extent, what compounds are conducive to the most perfect combustion; this has been accomplished with quite a number of different varieties by different investigators, with somewhat similar results. It has been quite generally observed that a large amount of potash in proper combination promotes, and a large percentage of chlorine retards combustion. Combining these facts alone with a knowledge of the susceptibility of the tobacco plant for taking up and retaining various plant foods, it is rendered possible for the grower to modify to a certain extent some of the conditions, which favor the formation of this desirable quality in the leaf. A study of the relations existing between the structure and composition on the one hand and the capacity for holding fire on the other, is often confusing, and the beneficial effects of one compound may be counteracted by the deleterious effects of another. When all the elements of structure and composition are considered, results are sometimes met with which seem unaccountable, but by considering the average of a large number of observations, more intelligent conclusions may be formed.

In comparing tables IV. and VII., with regard to the effect of structure and chemical composition upon the burning quality, the following salient points may be observed:

1. The best burning tobaccos were accompanied by a high percentage of ash constituents.

2. The presence of a large percentage of lime in the ash was accompanied with comparatively good burning qualities.

3. Potash existing in proper combination was conducive to complete combustion.

4. Other things being equal, the burning quality improved as the percentage of cellulose increased.

5. As a rule, a thin leaf with delicate structure burned better than a coarse heavy leaf.

6. Albuminoids seemed to have a deleterious effect upon the combustibility. It is believed that the same is true of some of the carbohydrates.

7. Nicotine is not an important factor in affecting the burning quality of tobacco.

8. It has been demonstrated by different writers that tobacco containing large amounts of chlorides does not burn well. Nessler found that an abundance of potash overcame the effects of chlorine to a certain extent. This seems to be verified in these results. Sample No. 474 contains nearly one per cent. of chlorine, and yet is one of the best burning leaves of all the samples; this sample also contains a high percentage of both potash and lime. In sample No. 480, we have a comparatively high percentage of chlorine but the potash is relatively small, and is accompanied by poor burning qualities. It

would seem, therefore, that while the presence of chlorine is objectionable, the deleterious effects may be to a certain extent overcome by the other constituents. Very large amounts, however, would not be counterbalanced in this way.

9. Of the several ash constituents which seem to be more or less interchangeable in the composition of the plant, according to the conditions attending growth, potash and lime are of most importance in promoting combustion.

10. GENERAL OBSERVATIONS.

In judging the quality of tobacco we are confronted with numerous difficulties. Unlike other agricultural products, it is extremely difficult to determine those desirable conditions which best adapt it to definite purposes. Its quality both from a physical and a chemical standpoint is dependent upon innumerable conditions which produce variations hardly rivalled in the plant kingdom. The dealer judges quality by the general appearance, and a high price is generally commanded, irrespective of species, by those tobaccos that have a large, smooth, thin and elastic leaf, possessing a desirable color and a good aroma. For wrappers which always bring the best price, it is essential that the leaves be free from holes or breaks, and the ribs thin and far distant from each other, while the lower the percentage of weight in ribs, and the thinner and broader the leaf, the more wrappers can be cut from a definite weight. It is impossible with present knowledge to determine with accuracy the quality of a certain product from a chemical analysis. There are certain facts, however, established by various investigations that have been of material benefit to the tobacco industry, while much has been learned concerning the climate, soil, fertilizers, curing, and their relation upon the quality and chemical composition. In addition to conclusions already drawn concerning the relation of the chemical composition to the burning quality, some further observations are given below concerning the growth and composition of tobacco, drawn from the data published in this bulletin, together with some facts of a general nature gleaned from other sources.

1. The largest average yields in the United States are from the New England States, where in some cases, the amount produced was from 1800 to 2000 lbs. per acre.

2. Most of the seed leaf and light body tobaccos are used for domestic trade, while the heavier types are employed largely for shipping purposes.

3. The seed-leaf varieties average the highest price, and the "bright" varieties of North Carolina and Virginia rank next in value, but these relative values are often changing.

4. With a few exceptions fertilizers are employed in the production of tobacco, but in very varying amounts. When it can be obtained, stable manure is a favorite to be used for the growth of heavy

tobacco in connection with commercial fertilizers. The largest amounts are used in the New England States, where it is not uncommon to apply from 1 to 1½ tons of high grade fertilizer per acre. In the Southern States very much smaller amounts are employed, and it is often customary on newly-cleared land to use little or none.

5. The land depreciates with continual cropping, except where large amounts of fertilizers and rational systems of rotation are employed.

6. The value of tobacco lands as they are quoted, is more largely due to local influences, as much as from the special merits possessed by these soils for the production of fine qualities of tobacco.

7. The land best suited for the production of a fine quality of tobacco is a well drained sandy soil or sandy loam.

8. Limestone and clay soils produce a rather strong tobacco with a large nicotine content.

9. All soils where successive cropping is practiced, require the addition of fertilizers to produce the best possible quality.

10. The chemical analyses of tobacco has been of considerable value in reaching a correct understanding as to the suitable plant foods for developing desirable qualities in the leaf.

11. Of the samples analyzed, the percentage of mid-rib in the leaf varied from 16.7 to 34 per cent. in weight. Owing to the great difference in the composition of the two parts, it is desirable that the analyses be made separately, in order that a correct understanding of the composition of the part actually used in manufacture may be ascertained.

12. While heavy manuring with nitrogenous manures may produce a somewhat inferior quality, especially with the heavier tobaccos, the gain in quantity will, under favorable conditions, more than compensate for the loss in quality.

13. The percentage of nicotine and albuminoids is materially increased by the use of large quantities of nitrogenous manures.

14. A large percentage of nitrogen in the form of albuminoids is usually accompanied with a large nicotine content.

15. The percentage of nicotine in the leaf is largest just as the leaf reaches maturity, but the amount is materially reduced by the various processes of fermentation to which the product is subjected before manufacture.

16. While nicotine is the active principle of tobacco and is desirable to a certain extent, it was found that the high priced varieties contained a relatively small percentage.

17. The nitric nitrogen is chiefly confined to the stems, and is not present in the leaf in appreciable amounts, except when large quantities of nitrogenous fertilizers are present in the soil. Its presence as such seems to be of no especial importance.

18. Relatively larger quantities of potash seem to be required for the growth and production of a good quality of smoking tobacco, than any other fertilizer constituent.

19. The percentage of ash constituents is governed to a large extent by the amount of available mineral compounds in the soil.

20. Good smoking tobaccos bring the best prices, and for this reason most attention has been given to their production. The requirements for chewing purposes are not so exacting, and the products which cannot ordinarily be used for smoking purposes are often manufactured into chewing tobacco, while the poorer grades, and in some cases the stems, are made into snuff.

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ISSUED BY THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

RALEIGH, N. C.

BULLETIN NO. 123

DECEMBER 14, 1895

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

N. C. STATE BOARD OF AGRICULTURE.

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RALEIGH, N. C.

PREFACE.

The accompanying bulletin is another instalment of the press service matter supplied to newspapers throughout North Carolina, as well as to other agricultural journals. It is reprinted as a regular publication of the Station, because in many instances results of tests are given which are not recorded elsewhere. It affords also a convenient medium for distributing collectively the short reading articles prepared with much care for newspaper columns. The parts inserted herewith were issued during August, October and November, 1895. In republishing these articles, the Station relies on the favor with which similar publications have been received in the past, as well as upon one of the mandates of the Hatch Act in endeavoring "to aid in acquiring and diffusing useful and practical information on subjects connected with agriculture."

H. B. BATTLE, *Director.*

THE EXPERIMENT STATION

AT RALEIGH, NORTH CAROLINA.

Harvesting and Threshing Cowpeas by Machinery—Insect Pests of Shade Trees—Feeding Calves—Questions and Replies.

August 1895.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. They are specially prepared to be serviceable as far as possible to the practical farmer. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited please do not apply for them as we have none to throw away. If you desire to read them, write on postal card to Dr. H. B. Battle, Director Raleigh, N. C.

Harvesting and Threshing Cowpeas by Machinery.

The great need of southern planters is an efficient machine to gather and thresh cowpeas. This is now done by hand and at a cost too great for them to become very widely planted for both a renovating and money crops. Correspondents have called attention to this matter, among them being Judge Walter Clark of the North Carolina Supreme Court Bench, and Prof. W. F. Massey of the North Carolina Experiment Station. Four parties responded, and all were invited to send a machine to be tested by the North Carolina Experiment Station. Only one of these, Mr. J. H. Gardner of Dalton, Ga., accepted the proposition, and his machine was tested by Prof. F. E. Emery, Agriculturist of the North Carolina Experiment Station, first on the farm of Mr. T. B. Parker, Goldsboro, N. C., and again on the farm of the Agricultural College at Raleigh. The machine is a thresher and not a harvester, and only threshes the peas from the pods after they have been picked by hand from the vines. The machine is known as the "Success Pea Thresher." At the first trial of 15 minutes 31½ lbs. corresponding to 2.1 bushels per hour, were threshed and fairly well cleaned. This required one man to feed the machine, while two turned the wheel. It was impossible for these two men to have continued with the same labor for more than half a day. At the second trial run for 44 minutes, the rate of 1.57 bushels per hour was secured. As compared with these results, three men were employed to whip out the peas by hand and to fan them clean also by hand. Occupied thus for 44 minutes, they secured the rate of 3.6 bushels per hour of cleaned peas. This is more than double the result from the Success Thresher in the second trial and nearly double from that in the first. The machine therefore cannot be recommended.

What is needed is a serviceable *Pea Harvester*, that will gather the peas from the vines in the field, and not merely a pea thresher. There have come to light two such machines in the investigation of the North Carolina Experiment Station upon the subject. These however need improvement and with some ingenuity and capital might be successfully placed on the market. Both of these are North Carolina inventions. One of them (the "Eureka") proposes to gather the crop from broadcast sowing, while the other picks from rows. This last (the Savage Pea and Bean Harvester) was shown in a test (North Carolina Experiment Station Press Bulletin No. 38) to gather 76 per cent. of all the peas when driven once over a row: with a second time, 86.86 per cent. were gathered, which was about as efficient as hand work.

A machine to gather peas from broadcast sowings however, is the one most needed, and if proven successful, and can be placed on the market cheaply, is bound to prove of great value both to the inventor and to farmers generally.

Insect Pests of Shade-trees.

During the last few years there has arisen an ever increasing strain of complaint against the insects which have begun to ravage the shade-trees in southern cities and towns. The alarming damage arises partly from the unchecked introduction and spread of foreign species of insects, but is chiefly owing to the mischievous English spar-

row, which is fast ejecting our native insectivorous birds, while itself prefering a different diet.

Among the most destructive shade-tree insects may be enumerated the following:

1—TENT CATERPILLAR—*Clisiocampa disstria.*

These worms form dome shaped nests in the crotches or among the branches of various trees, but more especially the oak and hickory. They also attack fruit trees. In some seasons, they devour the foliage over large areas in swampy regions, and then migrate in such swarms as to stop passing trains.

REMEDIES: Burn the nests out with a torch made by wrapping a rag saturated with kerosene around the end of a suitable pole. They may also be readily poisoned by spraying infested trees with Paris green,—1 lb. to 150 gallons of water.

2—FALL WEB-WORM—*Hyphantria textor.*

The webs of this insect become most painfully conspicuous in the late summer and fall months. The worms usually web together several leaves and eat the soft tissue, leaving the large veins and ribs. As fast as they consume the enclosed leaves they extend the web around others.

REMEDIES: The same as for the Tent Caterpillar. This worm feeds by preference upon the sycamore, poplar and white maple. It is also a pest in neglected orchards.

3.—THE ELM-BEETLE—*Galeruca Xanthomelæna.*

This insect is of foreign origin, only recently introduced and still chiefly found upon the European Elm. The worms are about ½ inch long yellowish with two black stripes on sides. The worms feed in swarms upon the leaves of the Elm, eating the green matter and leaving the ribs. They are most troublesome in July and August.

REMEDIES: Spray with Paris green. Gather up and destroy the pupa concealed under trash, boards, etc., under and near elm trees.

4.—THE TUSSOCK CATERPILLAR—*Orygia Cucostigma.*

This worm is easily known by the four tufts of white hairs on its back resembling the dauber of a shoe brush.

This worm feeds upon the leaves of most shade and fruit trees, usually devouring the whole substance beginning at edge of leaf. It does not spin a web, but has a habit of suddenly dropping from the tree by a cable which it spins as it falls. It is most common on the maple, elm and fruit trees.

REMEDY: Same as for No. 3.

The above described insects are only a few of the most destructive species known to exist in this state. Lovers of beautiful trees are requested to watch for the first appearance of these pests and promptly notify the Experiment Station, sending at the same time specimens of the insects and the foliage they damage. Special remedies will be given such as each case requires. Bulletin No. 100, our common insects can be had gratis by applying to Director H. B. Battle, Raleigh, N. C.

Some species of trees are more exempt than others from insect attack. In setting out new trees these species should be given the preference. Among such and well adapted to our climate may be named, Red Mulberry, Tulip-tree, Sweet and Sour Gums, Sugar Maple and Red Maple.—Gerald McCarthy, Etomologist, Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, July 1895.

The North Carolina State Weather Service issues the following advanced summary of the weather for July 1895, as compared with the corresponding month of previous years:

Temperature.—The mean temperature for the month was 75.2 degrees, which is 2.6 degrees below the normal. The highest monthly mean was 80.2 at Lumberton; the lowest monthly mean, 64.0 at Linville. The highest temperature was 99 degrees at Littleton, Tarboro, Rockingham, Saxon and Salem on various dates; lowest temperature, 43 on the 3d and 6th at Linville. The warmest July during the past 22 years was in 1887, with mean of 80.3 degrees; the coldest, in 1891, mean 74.2.

Precipitation.—Average for the month, 5.25 inches, which is 0.19 inch below the normal. The greatest amount was 9.03 inches at Southport; least amount, 2.32 at Asheville. The wettest July occurred in 1889, average rainfall 7.73 inches; the driest in 1883, average, 3.12.

Wind.—Prevailing direction, southwest, which is the normal direction for July. Average hourly velocity, 7.0 miles. Highest velocity 45 miles an hour from the southwest on the 24th at Kitty Hawk.

Miscellaneous.—Thunderstorms occurred at one or more places in the state

on every day except, 12th, 17th, 26th, 29th and 31st. But few reports of hail during the month.

The month was on the whole very favorable to agriculture.

North Carolina Weather During 1894.

The North Carolina Experiment Station has issued an attractively bound work entitled "North Carolina Weather during the year 1894." It embodies the results of meteorological and other observations of the state weather service during that year. The volume embraces 256 pages and includes a carefully prepared index and table of contents. It describes the work of the state weather service and through its several agencies, how it benefits the people of the state. The agencies are, the meteorological observing stations, the signal display stations, and crop reporting systems. The latter distributed weekly the weather crop bulletin for twenty-six issues, the signal stations display flags to note the coming of cold wave and frost warnings and changes in the weather, while the observing stations furnished observations for securing a correct record of our climate and weather. Another branch of the service which will prove of value is the flood warning system, by which people living on the low grounds of certain rivers are warned of the approach of floods. The number of places supplied by weather forecasts is nearly 500. The crop correspondents reporting for the weekly weather crop bulletin numbered 350 from all of the 96 counties. The meteorological observing stations numbered 73 from all parts of state.

The volume will be sent free to those who apply, provided they really desire to preserve such records and to learn of the operations of this division of the North Carolina Experiment Station.

Feeding Calves.

Two calves from grade Jersey heifers were left on their dams until six and three days old respectively. The first day from dams, the calves were fed freshly drawn mother's milk with nothing in it. The second day ⅝ mother's milk and ⅜ separated milk was fed. This proportion of mixing was continued five days. Then one pound of fresh milk to four pounds of separated milk was fed five days. The third period of five days the calves drak six pounds each of separated milk twice daily with one ounce of ground oats stirred into each mess.

During the fourth period of five days seven pounds of separated milk with one ounce each of ground oats and wheat were consumed at each of two feeds by each calf. For the fifth period of five days eight pounds of separated milk with one ounce each of ground oats and wheat as before, constituted the feed per morning or evening for each calf.

From the beginning of this feeding about a spoonful of lime water has been added to each feed. There was no scouring and both calves have grown well. This is shown in the gains of over one pound for one calf, and 1¼ pounds for the other calf per day.—F. E. Emery, Agriculturist N. C. Experiment Station.

Questions and Replies.

The Station will be glad to extend its usefulness by answering as far as possible questions on agricultural topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the North Carolina Agricultural Experiment Station, Raleigh, N. C. Replies will be written as early as possible by the member of the Station staff most competent to do so. and when, of general interest, they will also appear in these columns. The Station desires in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Acid Phosphate of Different Grades.

If you will kindly answer the following questions you will greatly oblige a number of farmers in this section:

Take two samples of acid phosphate:—One analyzes 12 per cent. the other 13 per cent.—Commercially one is worth $1.00 more than the other. Say that the dealer makes $1.00 difference in price; which is the cheaper acid to the farmer?

Some claim that there is an axcess of acid in most mixtures ond that 13 per cent acid when bougnt to compound with other ingredients is no better than 10 per cent acid. Is this not erroneous?

Take a sample of fertilizer analyzing a large percentage of moisture. Does this indicate only the mechanical conditions? Suppose after a time the fertilizers dry out is there any loss in weight?—T. T. C., Laurinburg. N. C.

(Answered by H. B. Battle. Director, North Carolina Experiment Station.)

On the supposition that the 12 per cent acid phosphate is sold for $12.00 and the 13 per cent is sold for $13.00, there is no difference in the value of the purchase. considering the amounts paid. The matter of greater weight of bulky materials in the 12 per cent article as compared with the 13 per cent article makes the latter somewhat better material to purchase, but if the

above prices are paid for materials delivered at the depot and only wagon hauling is to be considered, this difference is but slight. Of course the 13 per cent article is better than any article of lower grade. The terms in percentage are confusing to most people, but if the meaning is kept well before one, it is not apt to be misunderstood. Thirteen per cent means 13 pounds of available phosphoric acid in every 100 pounds of the goods; 10 per cent article contains 10 pounds to every 100, and consequently is 3 pounds less than the 13 per cent article.

A sample of fertilizer containing a large percentage of moisture in drying will not lose any of the other materials. The weight of the whole in bulk is less by the amount of drying but the original ingredients present in the 200 pound as first weighed will still be there, although there may not be but 185 pounds of the goods. But the analysis of the Fertilizer Control is generally made from samples taken after drying has taken place, and the decreased weight shows really a loss to the purchaser.

Grasses for Hay and Comparative Values of Hay.

I have tried a number of kinds of grasses and red and white clover—but they all die out in a short time except Herds grass—that seems specially adapted to this soil and spreads even where not sown. The land is swamp. the soil 12 to 30 inches deep and has a subsoil of clay. There is no marl within at least ten feet of the surface. Do you know of any other grass that will grow with the Red Top, and if so what?

I have tried liming for the clover, but it did no good. Is there anything else? What is the comparative value of the several grasses and clovers using timothy (hay) at $1.00 per 100 pounds as a basis? Also give value of corn fodder and cultivated soiling corn drilled thickly and allowed to ripen. When will be the best time to sow this grass seed after my corn comes off, which will be in December? W. R. M., Yeatsville, N. C.

(Answered by F. E. Emery, Agriculturist, North Carolina Experiment Station.)

If the land is not too wet Timothy should do well with the Red Top. *Bromus inermis* may do well for you. Orchard grass is also one of our most vigorous species and may do well if the land is not too wet.

Would recommend either Orchard grass or *Bromus inermis* (Ownless Beame Grass) or this mixture 1 bushel Red Top *Agrostis vulgair*, 1 bushel Foul Meadow Grass, *Poa serotina* 5 or 6 pounds Timothy seed and 4 to 6 pounds Perennial Red Clover.

Prepare the ground as soon as possible after the corn can be moved off. Sow the seed and top dress with stable manure and 200 or 300 pounds per acre of a good potassic manure or 500 to 1,000 pounds of wood ashes. This should secure a stand of grass if land does not overflow or is not too wet for the grasses named. Sow without oats. Grass does best without a nurse crop. From "Stewarts' Feeding Animals" a portion of a table is here adapted to show the relative values as requested. It shows that feeders of stock can do better than use all Timothy hay, and especially that some little valued forage plants are worth much more comparatively than Timothy.

	Stewarts value per 100 lbs.	Same Ratio Timothy $1.00 per 100 lbs,	
Timothy hay..	$.62	......	
Red Top Hay..........	.62	$1.00	
Timothy & Red Top..	.60	.97	nearly
Orchard grass hay....	.63	1.02	"
Johnson grass hay...	.71	1.14	
Crab grass hay.......	.70	1.13	nearly
Oat hay (cut in milk)	.68	1.10	"
Mixed hay...........	.58	.93	
Maize stover..........	.43	.69	
Maize fodder..........	.53	.85	
Oat straw.............	.47	.76	nearly
Wheat straw.........	.41	.66	
Cow-peavines.........	.80	1.29	
Clover hay............	.77	1.24	
Hay containing much ....clover	.73	1.18	nearly

The actual value consists more in what can be produced per acre than on the above comparisons of 100 pounds of each article. Maize fodder, and stover, cowpeavines, and Johnsons grass yield from two to four times as much as timothy hay averages.

The Lesser Locust Injuring Crops.

I enclose some of the different sized grasshoppers I am troubled with. I think they have changed somewhat in color, getting darker as they get larger. They have become so numerous that they are devouring truck of all kinds, but seem especially fond of melon vines. They also attack corn.—MRS. S. M. B., Wildwood, N. C.

[Answered by Gerald McCarthy, Etomologist, N. C. Experiment Station.]

The insects are the lesser Locust, *Caloptenus atlantis*. This is an indigenous species which ranges all through the Atlantic States from Maine to Mexico. It is not generally very troublesome. Where it attacks truck the Arsenite powder made according to formula No. 7, Bulletin 84 of this Station, will destroy it. Where it is abundant enough to damage field crops the only practicable remedy is the "hopper dozer" which must, however, be used by the combined farmers of a neighborhood. It will not pay a single farmer to attempt it. These insects will not last long should the weather be normally moist.

THE EXPERIMENT STATION

AT RALEIGH, NORTH CAROLINA.

Crop Conditions—Rust In Small Grain. Experiment Station Report—Co-Operative Dairying—Trucking In the South—Questions and Replies.

The Experiment Station Bulletin.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. They are specially prepared to be serviceable as far as possible to the practical farmer. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited please do not apply for them as we have none to throw away. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Crop Conditions During September, 1895

The following is extracted from the weekly weather crop bulletin of the state weather service for Oct. 7, 1895, and gives the crop conditions at the close of the season:

The month of September was favorable to about the fifteenth; then, however, a severe drought set in, with probably the most remarkable hot spell ever recorded in this State for September. The maximum temperature remained above 90 degrees (except in the mountain sections) for nine consecutive days, the highest being 103 degrees in the Central District and exceeding 100 at many points in the Eastern. These conditions forced a rapid opening of cotton; small bolls and leaves were shed considerably, and the top crop to a great extent was prematurely ripened. The corn crop was, however, beyond the reach of damage. All the smaller crops, late potatoes, peas, peanuts, etc., suffered from drought. The conditions were very favorable for saving hay and fodder, of which large quantities have been stored. But fall plowing and planting have been completely interrupted by the dryness. At the end of September, streams and wells were getting very low.

The drought continued during the first week of October, and farming operations are at a standstill except picking cotton, which has progressed rapidly, and gathering of corn Cotton has opened so rapidly that the crop will probably be gathered early. The harvest of rice is about completed. On the first of October frost occurred over a considerable portion of the State, which did some damage to tobacco yet uncut.

The following table shows the departure in temperature and precipitation for each month during the season:

Month.	Departure in Temp.	Departure in Precip.
January	—1.9	+1.89
February	—12.2	—1.83
March	+0.1	—0.37
April	+0.8	+3.51
May	—2.8	+0.63
June	—0.1	—0.81
July	—2.6	—0.19
August	+0.5	—0.59
September	+4.5	—4.00

Rust in Small Grain.

The rust disease of wheat oats, barley and grasses generally, are caused by one or more of three species of microscopic fungi. The most commoon rust on grasses in this State is *Pucinnia graminis*, generally called "Mildew" on grasses, and "Black Rust" on cereals. Our most common rust fungus on small grain is *Pucinnia Rubigovera*, usually called "Red Rust." *Pucinnia coronata*, also called Red rust is the third. The last species is more common on oats than on any other and might be properly called oat rust. All three species belong to the class of parastie fungi called *Heterœcismal*, that is to say, fungi which at different times in the cycle of their growth live as parasites upon two or more hosts. Grass mildew, *Pucinnia graminis*, begins its spring growth by attacking the young leaves of the Barberry, Mahonia, and possibly other shrubs. Upon these it produces small redish patches with elevated margins called "cluster cups." These cups are filled with the red Aecidio spores of the fungus which wafted by the air or carried by insects, birds or other agent fall upon the leaves of grasses or cereal grains and there penetrate the leaves through the breathing spores. Once within the leaf the spore sends forth a net work of root-like tissue called Mycelum. Through this, it sucks up the sap that should go to nourish the seeds

of the plant and these latter shrivel up. Very soon the fungus bursts through the epidermis of the leaf and appears upon the outside as the well known, elongated, narrow red spots, popularly called "Red rust." These are the uredo spores of the fungus and are able to reproduce themselves upon the same or other grass like plants and subsequently they produce the last form in the life cycle, the black, teleuto spores which form the narrow black lines seen on the leaves and stems of cereals and grasses in late summer and fall. These black spores are the winter or resting spores and will under favorable circumstances retain their vitality in the straw or even on the ground for a year or more. Eventually some of them alight upon the leaves of their alternate host and there produce again the cluster cups and Aecidio spores and these the uredo and teleuto spores.

The three fungi which attack grasses and cereals do not all have the same alternate host. *Pucinnia graminis* has for alternate hosts, the barberry, mahonia and probably other shrubs. *Pucinnia coronata*, has for its alternate hosts the buck thorns, *Rhamus lanceolota, frangula* and other species. *Pucinnia Rubigo-vera* has for its alternate hosts the common and disagreeable weeds Viper's buglass, *Echium vulgare*, and Gromwell, *Lithospermum arvense*.

Knowing that to complete their cycle of growth these fungi require a host widely different from grasses and grains if we could extirpate all such host plants within a half mile or so of a grain or grass field we could effectually stop their further development. Yet we can not hope to exterminate these pests in one or two seasons even by completely destroying their alternate host-plant. Once the "Red rust" or uredo spores of the *Coronata* and *Rubigo-vera* species are produced on grains or cereals, these in our warm climate where growing glumaceous plants are found in a green condition all the year round may go on reproducing themselves indefinitely as well as producing at the same time the succeeding black form, the teleuto spores, which are then able to stock the ground or infect any chance alternate host plant which negligence or accident may allow to remain.

As these spores are extremely small and light and are produced in almost incredible numbers the few alternate host plants which may survive even the most watchful care may supply æcidio spores enough to infect hundreds of acres of grass or grain.

Common and destructive as the rust fungi are in the United States, in Australia they are still more so and several conventions of scientific men and practical farmers have been held there to devise methods for repressing the pests but so far without much success. Practical experience recommends the following measures:

1. Use dry or well drained land for small grains.
2. Plant only hard stemmed, hairy, early maturing varieties of wheat.
3. Plant those varieties which in your locality resist rust best—the socalled "Rust proof" wheat and oats.
4. Sow thinly to give plenty of sunlight and air to the plants.
5. Plow the land deeply as soon as the crop is harvested to destroy volunteer growth or burn the stubble and straw on the field. The latter plan is best where grain is grown on a large scale.
6. Carefully search out and destroy all alternate host plants found within one half mile of a wheat or oat field.
7. Rotate crops so that some crop other than grasses or cereals will come on the land each two years out of three.
8. The use of fungicidal sprays on growing grain has not so far given satisfactory results. The best fungicides for this class of plants are: 1. Simple solution of Iron Sulphate. 2. Copper sucrate. Directions:—Apply in the finest possible spray as soon as the grain begins to flower—repeat every ten days until grain is in the dough. Then harvest it. For formulas for preparing these fungicides see bulletin No. 84 of this Station—Formulas 1 and 3 page 7.—Gerald McCarthy, N. C. Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, September, 1895

The North Carolina State Weather Service, issues the following advanced summary of the weather for September, 1895, as compared with corresponding month of previous years:

TEMPERATURE.—The mean temperature for the month was 74.2 degrees, which is 4.0 degrees above the normal. The highest monthly mean was 78.4 at Newbern; lowest monthly mean 62.6 at Linville. The highest temperature was 104 on the 22d and 23d, at Tarboro; lowest 32 on the 30th, at Blowing Rock and Highlands. The warmest September during past twenty-two years was in 1881, with mean 74.9 degrees, the next warmest is September, 1895. The coldest September was in 1875, mean 67.0 degrees.

PRECIPITATION.—Average for the month 1.25 inches, which is 3.40 inches below the normal. The greatest amount was at Hatteras; least amount 0.05 at Kitty Hawk. The wettest September occurred in 1877, with an average of 10.13 inches. This September of 1895 was the dryest on record for past twenty-two years.

WIND.—Prevailing direction, South-west. The normal direction as deducted from many years observations is northeast. Average hourly velocity, 6.5 miles. Highest velocity, 48 miles an hour from the Northeast on the 30th at Kitty Hawk.

MISCELLANEOUS.—Thunderstorms occurred at various places on the 1st, 5th, 6th, 8th, 9th, 13th, 16th, 17th, 18th, 19th. Lunar halos on the 2d, Solar halos on 2d and 3d. Meteor observed at Settle on 22d. Frosts appeared in the western portion of the State on the 29th and 30th.

The North Carolina Agricultural Experiment Station During 1894

The above is a title of a work issued by the station. In connection with the volume, "North Carolina Weather During 1894," it includes all the finished work done by the station during 1894. The volume contains 605 pages, and a full table of contents and index make it easy to refer to any part of the subject matter. An interesting portion of the report gives the several benefits the station has been to the farmers of North Carolina. There are recorded 140 of these, and a more detailed summary might easily multiply them to a considerable degree.

The report includes all the bulletins issued during 1894, from Nos. 94 to 110 inclusive. With the full index, any subject treated in these bulletins can readily be found. The general subjects embraced in addition are the operations of the Fertilizer Control Station and the State Weather Service, which are integral parts of the Experiment Station. Each of these is described in detail.

The above report is not sent to the full mailing lists of the station, but is supplied to those in North Carolina who apply for them. To others on receipt of 25 cents.

Co-Operative Dairying.

The station has been ready for some time to assist farmers in undertaking some co-operative dairying.

Up to date for over five months one farmer has furnished some milk to the Station Dairy at the Experiment Farm. As a part of the practice of a special student, this small milk supply was examined five days and daily tests made of the per cent of fat. This milk was separated by itself and the skim milk was tested each day. Then the cream which had been kept by itself was churned and the butter milk was tested. Subtracting the amount of fat formed in skim milk and butter milk from what had been found in the milk for five days, left what was incorporated into the butter or lost in the mechanical operations. The total amount thus found calculated as butter at 85 per cent fat indicated a yield of .205 pound less than was actually made for sale.

This milk was paid for by the Babcock test, or rather the fat was paid for, and the skimmed milk was returned to the producer. At 25 cents per pound for butter fat an average of \$1.27 per 100 pounds was realized for the milk. This is 11 cents nearly per gallon. At the dairy, if we count the butter worth at wholesale price of 25 cents per pound, there were 4 cents per pound realized for the making and selling. When the selling price was 27 cents per pound there was realized \$0.597 on ten pounds and seven ounces of butter. This would be 5.7 cents per pound which, if it could be carried out on a sufficiently large scale, would pay well. It would also pay well to produce milk at 11 cents per gallon for the butter fat contained in it, and have the skim milk returned to feed pigs, calves and chickens, or possibly lambs.—F. E. Emery, Agriculturist, North Carolina Experiment Station.

Trucking In the South.

A bulletin (No. 112) has been issued by the North Carolina Agricultural Experiment Station, describing the methods deemed advisable for raising trucking crops especially in North Carolina. These crops are asparagus, beans, beets, early and late cabbages, cauliflower and lettuce, cucumbers, celery, egg plant, muskmelons and watermelons, onions, peas, Irish and sweet potatoes, radishes, spinach, tomatoes and turnips. There are 68 pages devoted to this bulletin and the various subjects are treated in a thoroughly practical way. An appendix of 14 pages describes the various formulas suggested for the several crops, what ingredients to use to give the desired percentages for the different crops, and how to mix them. This bulletin is sent free to parties in North Carolina requesting it, and to others on receipt of 10 cents in postage.

Questions and Replies.

The Station will be glad to extend its usefulness by answering as far as possible questions on agricultural topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the North Carolina Agricultural Experiment Station, Raleigh, N. C. Replies will be written as early as possible by the member of the Station staff most competent to do so, and when, of general interest, they will also appear in these columns. The Station desires in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Onions for Market.

Which is the best onion to grow for market in this section?—J. S. D. V., Brinkland, Bladen Co., N. C.

[Answered by W. F. Massey, Horticulturist N. C. Experiment Station.

It depends upon how you propose to sell your onions. If you wish an onion to sell early as a green bunch onion, I would advise you to plant in October sets o. the Early Pearl, or of the white potato onion. If your object is to grow a mature crop of onions, that will keep for late sales, then I would sow in February seed of the Southport White Globe, or the Opal (red). Or you may, if you have some glass sashes, sow seed of the Prizetaker in a frame under glass, in January, and transplant the young plants in March and get a crop of extra sized onions. But this variety must be sold as soon as ripe for they will not keep. The big yellow onions now seen at the stores are of this variety.

The Harlequin Bug.

Can you give remedy for the cabbage beetle that is destroying my cabbages and turnips?—J. R. G., Durham, N. C.

[Answered by Gerald McCarthy, Entomologist.]

The insect you complain of is the Fenopin or Harlequin Bug, now becoming the worst pest of the cabbage family every where throughout the South. This pest seems proof against all available poisons. Hand picking is the only practical remedy for this insect. Use a shallow pan with a handle. About one-fourth fill this with water and on the water pour a film of kerosene oil one-fourth inch thick. Place the pan under or at side of the plants and shake or jar the plants; the bugs will easily drop into it and be killed by the oil. Be careful that the oil does not spatter on the plants as it will burn them.

Beets for Stock Feed.

Will sugar beets be a good feed for hogs and milch cows?—H. W., Newton, N. C.

[Answered by F. E. Emery Agriculturist, N. C. Experiment Station.]

Yes, they are good but owing to expense in growing and harvesting they aro not much used for that purpose. Sugar beets grow wholly underground and the leaves spead on the surface. They are considerably covered with fine roots which hold much dirt from most soils and this should be washed off before feeding the roots which is another expense.

There are varieties of stock beets called mangolds, or sometimes mangels which grow mostly above the ground which are comparatively free from soil holding roots. These are more easily grown and harvested though they do not contain so much sugar.

Variety of Trees for Peach Orchard.

"I wish to set a peach orchard so that I will have three or four trees bearing all the time from June to October. Will you please advise me as to what varieties to get?—J. T. F., Burlington, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experimental Station.]

I would suggest the following varieties: Alexander, Mountain Rose, Early York, Mary's Choice, Reeve's Favorite, Old Mixon Free, Elberta, Crawford's Late, Beer's Smock, Wilkins' Heath, Salway, and Chairs' Choice.

Varieties of Trees For Apple Orchard.

I wish to set out an apple orchard. Would like to have a variety, say two or three to ripen each month, from June to October. Could you offer any suggestions as to those best suited to this (Richmond) county?—J. Mc. P., Laurel Hill, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.]

I think that you will find the follow-list a good one for your section:

Early Apples—Red Astrakan, Carolina Red June, Yellow Transparent, Early Harvest. Fall Apples, Magnum, Bonum, Maryland Maiden's Blush, Fallawalder Winter Apples—Winesap. Limber Twig, Golden Russett, Buckingham, Grimes' Golden, Junaluskee, Nickajack, York Imperial.

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

AT RALEIGH, NORTH CAROLINA.

Testing the Milk of Cows—Beware of Seed Peddlers—The Poultry Division—A New Cabbage Pest—Questions and Replies.

November, 1895.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. They are specially prepared to be serviceable as far as possible to the practical farmer. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited please do not apply for them as we have none to throw away. If you desire to read them, write on postal card to Dr. H. B. BATTLE, Director, Raleigh. N. C.

Buying and Selling Cows by Tests of Their Milk.

The North Carolina Experiment Station proposes a plan for buying and selling cows. It is based on the yield of their milk, together with the quality of the same as determined by tests of the milk. The rule is to pay for the cow at the rate of $12 per gallon of milk given per day that is rich enough to show 3½ per cent of fat. To this price add or subtract one dollar for every one-fourth of one per cent of fat which is above or below the 3½ per cent. By this rule a cow is bought entirely on her merits. It is believed to be a conservative plan, and one if adopted (or one upon a similar plan) will certainly raise the standard of cows and increase their milk and butter production, for if they cannot be sold easily for milk cows, they will soon be turned over to the butcher, and a better animal be kept or a willing purchaser be found. The result cannot fail to be beneficial to all parties.

Beware of Travelling Seed Peddlers.

Farmers of the state should be on their guard against travelling seed peddlers who, it seems, have been operating in the eastern, and probably other districts of the state. A farmer near Rocky Mount, N. C., sends the Experiment Station a circular distributed by these persons. The following extract will suffice to show how they are trying to deceive and swindle the farmers:

"TRIFOLIUM OR SWEDISH HYBRID.

"An everlasting, perennial plant * * * It resembles all other varieties of clover, peas, beans, etc., grows two to four feet high on ordinary land and is adapted to thin or sandy soil. It is far superior to manure to plow under."

To a person having knowledge of such matters, the whole of the above quotation is pure fiction. The plant referred to is Alsike clover, a short lived perennial adapted only to rich moist land and a cool climate. It has no value for North Carolina or the South outside of the higher mountain valleys. Farmers who buy and plant it under such representations will be woefully disappointed and will suffer loss of all invested in the seed.

The New Poultry Division.

The North Carolina Agricultural Experiment Station has added another division to the several already in operation, to be known as the Poultry Division. Among the specific studies for this division will be first to ascertain the best breeds of poultry which can be recommended for different sections of the State, how to raise them economically, including the best treatment for diseases and insects, and how to prepare and ship to market all poultry products.

It will be the endeavor to foster the industry in North Carolina so that a profitable and financially paying business may be inaugurated in almost any locality, or on any farm. As but little capital is required, the returns for the investment should always be large. The Station proposes to publish educational bulletins to bring the matter before the attention of the people of the State, and to extend such knowledge to all who raise poultry, as would be of benefit in the management, preparation and shipment to market.

The poultry manager in charge of the Poultry Division of the Experiment Station will be Mr. F. E. Hege, now of the Riverside Poultry Farms of Newbern, N. C. He will enter upon his work on December 1st, on the farm of the Station adjoining the State Fair Grounds.

The raising of poultry and poultry products in North Carolina for market is susceptible of great extension, and this new departure by the Station will, without doubt, contribute largely to that end, and will prove, consequently, of great and far reaching value.

Advanced Monthly Summary of Meteorological Reports For North Carolina, October, 1895.

The North Carolina State Weather Service issues the following advanced summary of the weather for October, 1895, as compared with the corresponding month of previous years:

TEMPERATURE.—The mean temperature for the month was 55.8 degrees, which is 3.9 degrees below the normal, and the lowest for October since 1873. The highest monthly mean was 62.8 at Southport; lowest monthly mean 44.5 at Linville. The highest temperature recorded was 88 on the 7th at Rockingham; lowest, 18 on the 10th and 30th at Linville. The warmest October during the past 23 years was in 1881; mean, 66.4 degrees; the coldest in 1873 and 1895; mean, 55.8.

PRECIPITATION.—Average for the month, 1.86 inches, which is 1.80 inches below the normal. The greatest amount was 2.99 at Tarboro; least amount, 0.21 at Asheville. The wettest October during the past 23 years was in 1887; average, 6.72 inches; the dryest was in 1884, average 0.81 inch.

WIND.—Prevailing direction, northeast, which is the normal direction for October. Average hourly velocity, 8.6 miles. Highest velocity, 52 miles an hour from the northeast on the 4th at Kitty Hawk.

Frosts were most general on the following dates: The 1st, 2nd, 3rd, 9th, 10th, 11th, 18th, 19th, 20th, 21st, 22nd.

Solar halos were observed at various places on the 11th, 14th, 15th, 29th, 30th.

Lunar halos were observed on the 1st, 2nd, 28th, 29th, 30th.

Ice formed in the western portion of the state on the 1st, 2nd, 3rd, 10th, 11th, 20th, 21st, 22nd, 29th, 30th.

Earthquake shocks were felt in the eastern portion of the state on the 6th, in the west on the 31st, both slight.

The month was characterized by the long drought, which was not broken until the 31st.

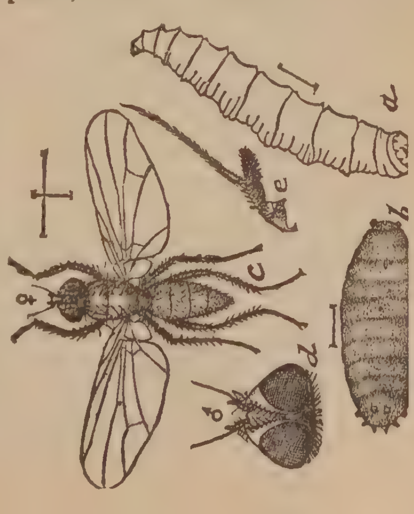
The Testing of Milk.

A bulletin recently issued by the North Carolina Experiment station (No. 113) describes the different methods employed for testing milk, cream, buttermilk, etc., also for testing the adulterations in milk. The Babcock milk test is the chief method employed for the purpose. It is described in detail and anyone with care and short experience can soon learn how to conduct a test. Anyone who has several cows should know the relative value of each, and it often happens that a cow eats more food than is returned in her products. It is a waste to keep such stock. The Babcock test affords an easy plan for learning the richness and value of the milk. A person possessing the apparatus, which is simple and comparatively inexpensive, (costing only about $10) can easily test the milk of the cows belonging to his neighbors and charge a small amount for the service. Such a plan would be helpful and saving to both parties. Or else several could buy the test apparatus in common. An illustration (from a photograph) is given in the bulletin showing the appearance of two cows, one of which produced 226 pounds of butter per year, while the other produced 296 pounds. This was determined in the above way by the testing of the milk, and shows the variation which may and often occurs in two cows of the herd. The difference is 31 per cent greater than the poorer cow. The milk of cows varies in quality, and unless the quality is known together with the yield it oftens happens that cows are kept that are not profitable, and should be turned into beef.

A New Cabbage Pest.

The cabbage maggot, the larval form of a fly, *anthomyia brassicæ*, is the most destructive pest of the cabbage in Europe, where it sometimes destroys whole fields of young plants. It has been occasionally troublesome in the United States since 1846. It has the past spring appeared in alarming numbers in a portion of the trucking section of this state.

The fly is slender and gray colored, rather smaller than the common housefly. The female lays her eggs in early spring on the roots or stem of young plants, both in the seedbed and field.



The eggs hatch out in about five days. The maggots eat off the young rootlets producing what is often called "club-foot;" they also bore into the larger roots and stems, causing the plants to turn yellow and soon after die, or remain as stunted plants which refuse to head. The flies continue to breed all the summer and pass the winter as dormant pupa in the hollow stems of cabbage and stumps if left in the field. Some of the winged insects also hide away in cellars and places where cabbage is stored, but the greater portion of the first brood of flies come from the dormant pupa in the field. The maggots feed by preference upon the roots of cabbage and other cruciferous plants—collards, kale, cauliflower, radish, mustard, etc., but they breed also in stable-manure piles, human excrement and rotten fish.

REMEDIES.

The first and most essential remedy is to clean cabbage fields thoroughly of stumps. Either plow these under at least 6 inches deep and then roll the ground, or gather the stumps and compost them with lime. Never follow cabbage by the same crop on any field. If the maggots appear on plants in the seed bed, apply a good dressing of lime or muriate of potash to the soil, or sufficient kerosene emulsion to wet the ground 1 inch deep. If plants in the field are attacked take a dibber or sharp stick and make a hole near each plant as deep as the roots of the plant and about 1 inch in diameter. Fill this hole with kerosene emulsion. If the emulsion does not wet the soil on all sides of the plant make and fill another hole on opposite side. Usually one treatment will be sufficient for each crop, but if neighboring fields are left untreated they will breed flies so fast that a second treatment may be necessary after ten days. The emulsion must be thoroughly made. But it will be safe in any case if it is not allowed to touch the leaves of the young plants.

THE KEROSENE EMULSION.

Hard soap, ½ pound.
Water, 1 gallon.
Kerosene oil, 1 gallon.

DIRECTIONS.—Shave the soap and boil till all dissolved in the water. Remove from the fire and pour into the kerosene. Churn this or pass it through a sprayer or syringe until it becomes a thick cream and the oil does not separate from the soap. Dilute with 9 times its bulk of cold water before using.

This remedy is equally as good for the onion maggot, cut worms and all other burrowing insects. When thoroughly made it would not burn the plants, but if any free oil rises to the top it will burn.—GERALD MCCARTHY, Entomologist, N. C. Experiment Station.

Questions and Replies.

The Station will be glad to extend its usefulness by answering as far as possible questions on agricultural topics sent by any one in North Carolina who may desire to ask for information. Address all questions to the North Carolina Agricultural Experiment Station, Raleigh, N. C. Replies will be written as early as possible by the member of the Station staff most competent to do so, and when, of general interest, they will also appear in these columns. The Station desires in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

The Growing of Onions.

Would there be a possibility of my growing a good crop of onions on newly cleared land, with everything taken out and well plowed and worked? I want to grow a good crop. I have nothing but commercial fertilizers to use. My land is light and high, a good sandy loam. How much fertilizer can I use and not burn the crop? Is the "Prizetaker" the best for me to plant, and market under the "New Onion Culture?" What time are they ready to market set out February 1st.—A. F. C., Chadbourn, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.]

You can doubtless grow a fair crop of onions on your land, by liberal fertilization, and by repeating the heavy fertilization, you can grow larger crops on the same land annually for a number of years. It takes several years fertilization and culture to get the maximum crop of onions on a piece of land that has never grown that crop. I should use fully a ton per acre of a high grade fertilizer, and I would not buy any particular brand of mixed fertilizer, but would mix my own, for there is no brand that I am acquainted with which has as large a percentage of potash as the onion crop and your soil need. In bulletin 112, on Trucking in the South, you will find some formulas for home mixing of fertilizers. If you wish to grow green onions for bunching to ship in March, you should use sets of the Early Pearl or the White Potato onion, and plant them in October. The bulletin referred to will give you full directions. For a ripe crop for the home market or for early shipment ripe, you can use the Prizetaker, and start the plants under glass in January, or if you want a crop that can be kept then sow

seed in February of the White Southport Globe, or the Red Opal. The Prizetaker is the best for the "new onion culture," that is the starting of the plants early and transplanting in March, or with you in February, if well hardened off. They will be ready to ship in late June or early in July, while the onions grown from sets planted in October, will be ready to pull and bunch in March and ship with the tops on, in ventilated barrels.

Do Oats Impoverish the Soil More Than Wheat?

People here contend that oats draw or impoverish land a great deal more than wheat. They say that crabgrass and weeds will not grow on land when oats have been removed, or not so fine growth as where wheat has grown. They argue that both crops may be seeded at the same time. Is it so, and if so why? Some information will be gladly received. J. W. F., Durham, N. C.

[Answered by F. E. Emery, Agriculturist. N. C. Experiment Station.]

The difference between what wheat and oats take out of the land can be shown after we settle what should be considered a fair crop of each. Suppose 20 bushels of wheat and 40 bushels oats are an average crop. Which draws out most plant food from the soil? The station wheat experiments in 1891 yielded an average of 217 pounds of straw to 100 of grain. In 1888 experiments with oats at New York state station, yielded 128.4 pounds of straw to 100 pounds of grain. Using these relations of grain to straw the crop taken off from an acre of each grain would be for wheat: 1,200 pounds grain and 2604 pounds straw; for oats, 1280 pounds grain and 1643.5 pounds straw. From the New York station report for 1888 the following table is taken: It shows the pounds of plant food removed from the soil in 1 ton of 2,000 pounds of each article named:

	Lbs. of Plant Food in 2,000 lbs. of			
	Wheat	Wheat Straw	Oats	Oat Straw
Ph. Acid (P_2O_5)	15.1	2.0	11.9	1.2
Potash . . (K_2O)	8.8	10.5	9.8	27.0
Nitrogen . . (N)	34.2	9.5	39.0	7.6

Therefore from an acre each of wheat and oats from which the yields obtained are equal to the above assumption, the following amounts of plant food in pounds would be withdrawn from the soil:

	Lbs. of Plant Food contained in Each Crop.					
	Wheat Crop			Oat Crop		
	Gr'n	Str'w	Total	Gr'n	Str'w	Total
Phosph. Ac. (P_2O_5)	9.06	2.60	11.66	7.62	0.99	8.60
P't'sh(K_2O)	5.28	13.67	18.95	6.27	22.19	28.47
Nitr'g'n (N)	20.52	12.37	32.89	24.96	6.25	31.21

In this case the wheat would carry off more phosphoric acid by 3 pounds and more nitrogen by 1⅔ pounds, while the oats would take 9½ pounds more potash than the wheat.

It is a matter of common observation among farmers that oats are a far better forager than wheat. That is, given an equal chance, the oats can get more and do better than wheat. Hence it is owing to the recognition of less ability of wheat to produce as well under like conditions that it is given the better of two fields where both crops are grown on the same farm and that determines the application of commercial manure to the wheat oftener, or in greater weight than for the oat crop.

Under equal conditions to start with, the oat crop would produce more, and would take more from the soil than wheat. It does not, however, on average conditions as met with, and the contention referred to, depends finally on the condition of the land previous to cropping with wheat or oats, and on the application of commercial or other manure made for the crop. Grasses require an abundant food supply in order to make any considerable growth. They cannot find it after as close a forager as oats has been removed from a rather poor field to begin with and but little help offered. They can find food after a wheat crop on better or even the same land, especially if some compost, stable or commercial manure was used to help the wheat. It will doubtless *pay* to dress land well for wheat and sow cowpeas on the stubble to be worked in with gang plow, or disk harrow, and harvest the crabgrass and cowpea hay, which will result on many North Carolina soils.

In regard to time of sowing, there is a great deal of latitude for both crops in North Carolina. The custom is to sow in September or October. In the east it is allowable to sow later than in the west. Even as late as Christmas has produced a good crop of wheat here on the Experiment Farm. Early sowing saves some expenditure for nitrogenous manure by depending somewhat on the nitrates of the soil, which may be largely lost before late sown grain could feed on it. Wheat is doubtless more benefited by early sowing than oats.

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